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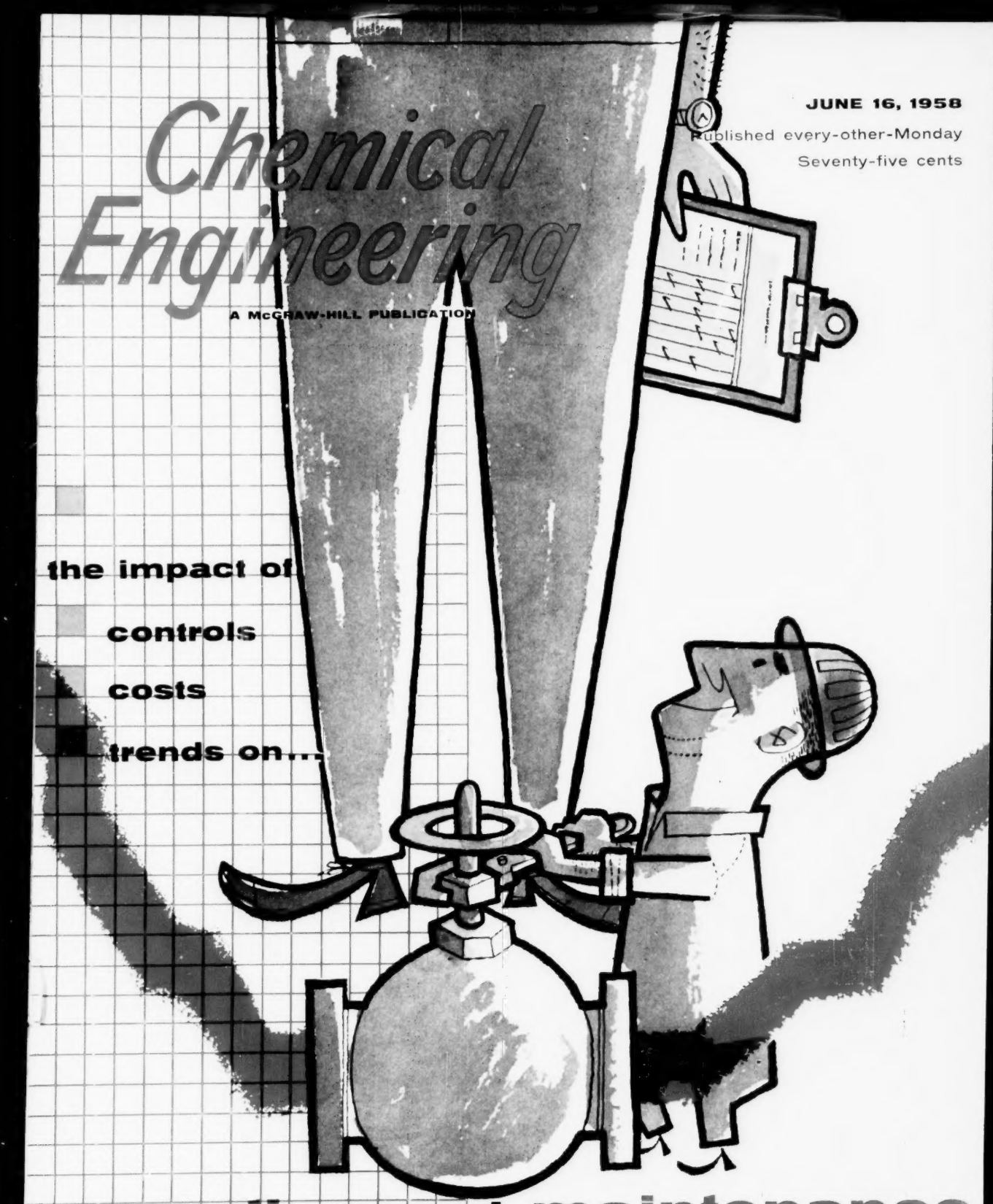

the impact of controls costs trends on...

operation and maintenance

SELECT AND DESIGN FOR O & M — SEE PAGE
RECIRCULATED SALTWATER COOLING — PAGE
YOUR CE COST FILE — PAGE TWO

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JUNE 16, 1958

JOHN R. CALLAHAM, Editor-in-Chief

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In this issue you'll find the first of a brand new series on costs . . . CE Cost File . . . which we believe will develop into a distinctive addition to the chemical engineering literature.

Only a dozen years ago there were virtually no published sources for the chemical engineer on costs and cost estimation methods.

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What kind of material will the new CE Cost File series specialize in? How will the data be presented? Who will be the authors?

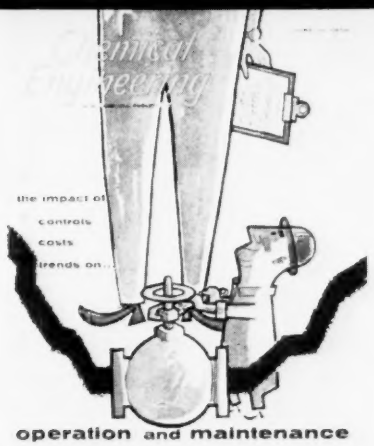
▶ **What**—Concise, usable, up-to-date correlated data for preliminary cost estimates in all areas of particular interest to chemical engineers: Equipment, materials, facilities, labor, energy, services . . . development, design, construction, operation, maintenance, overhead . . . the field's wide open!

▶ **How**—As graphs, tables, charts, formulas, indexes, correlations . . . concise, condensed, a minimum of text.

▶ **Who**—By any reader of CE who's able and willing to contribute. We'll pay regular space rates for all accepted material.

We think you'll find that this new series can often help you (and through it you can help others) in many areas of costs and cost estimation.

CE Cost File begins on p. 187.



TWELFTH OF TWENTY-SIX ISSUES

12/26

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Today's trends have changed maintenance to a vital part of the plant-operations function. Now is a time of integration. And here is a pioneering report that underlines the changes. It explores three of the important trends. It gives practical help for the designing and operation of six kinds of equipment. (p. 141)

Today's trends in O & M

Here's a rundown of three trends foremost among those affecting operation and maintenance: growth of production technical service groups, maintenance by contract, leasing of equipment. (p. 144)

Select and design for O & M

And here's help in designing and selecting equipment when operation and mainte-

Chemical

GUIDED TOUR

nance are properly considered. Included are dryers, filters, mixers, thickeners, pumps and materials handling equipment. (p. 154)

How salt water can be used for cooling

Ordinary sea water can now be used for cooling process units. Secret of success in this novel cooling tower design is skillful use of materials of construction to combat salt water corrosion. (p. 181)

Concise, usable cost data

How many dollars? That's the question your CE Cost File is going to answer. It's the latest CE Series. Every installment will bring new or better data to help you with your cost estimating. (p. 187)

From mental effort, a special problem

Usually unrecognized, mental fatigue can be a special problem affecting highly skilled work. Now you'll understand what it does and why it's important to you, to engineers and to management. (p. 191)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:

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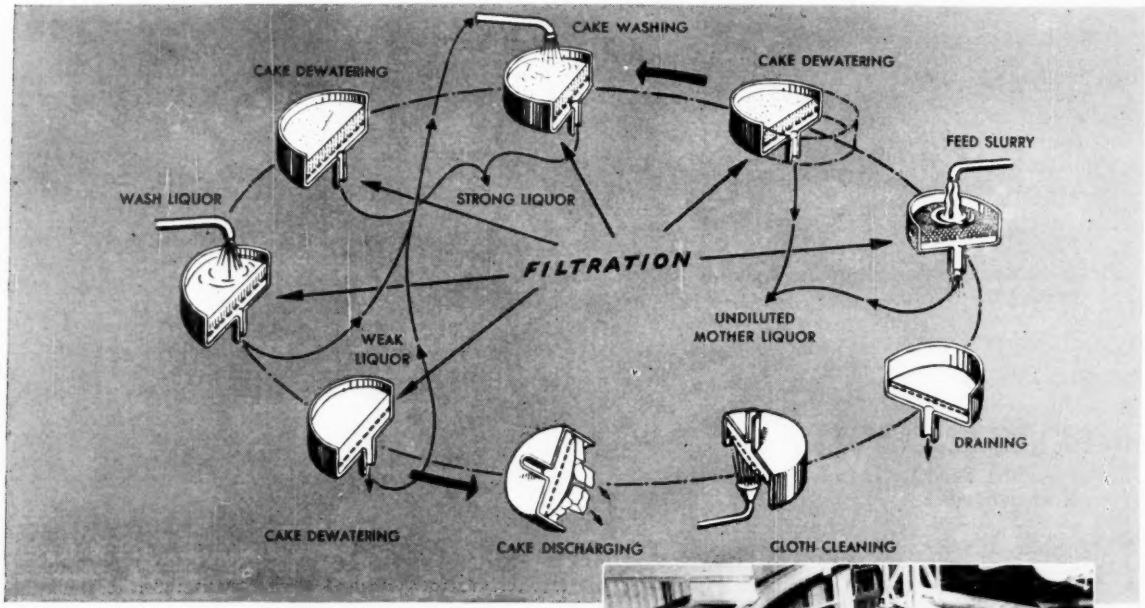

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Effective Counter-Current Wash with the Least Amount of Wash Liquor. With the Bird-Prayon, solubles in the cake get down to an irreducible minimum using a fraction of the wash water required by other filters. Complete cake discharge and thorough washing and drying of the filter media every time around prevents contamination or dilution of the incoming feed.

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JUNE 16, 1958

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In this issue, you'll find a special report: and, starting July 28, a new department: Operation and Maintenance—to become a regular feature of *Chemical Engineering*.

Short of fresh water for cooling? Use salt water..... 181

With this new tower design, your refinery can now tap salt water for cooling purposes, yet sidestep corrosion snags and cut capital costs by a hearty 65%.

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Because design calculations depend on concentration change whenever phase composition shifts as it does, say, in gas absorption, you must know how to handle these equations.

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Next issue: What material do you use above 2,500 F.?

Progress in theory and application for processing at high temperatures have called for special super-refractories. Here's what to expect of their ultimate uses tomorrow.

TRANE FLUID COOLERS cool either liquid or gas, condense vapors, with air as the cooling medium. Model shown is a vertical air discharge unit. Horizontal discharge units also available—both types in a complete range of capacities.

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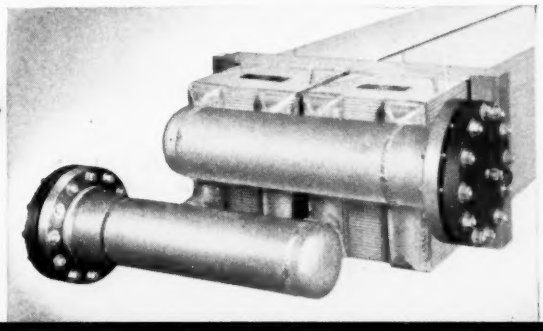

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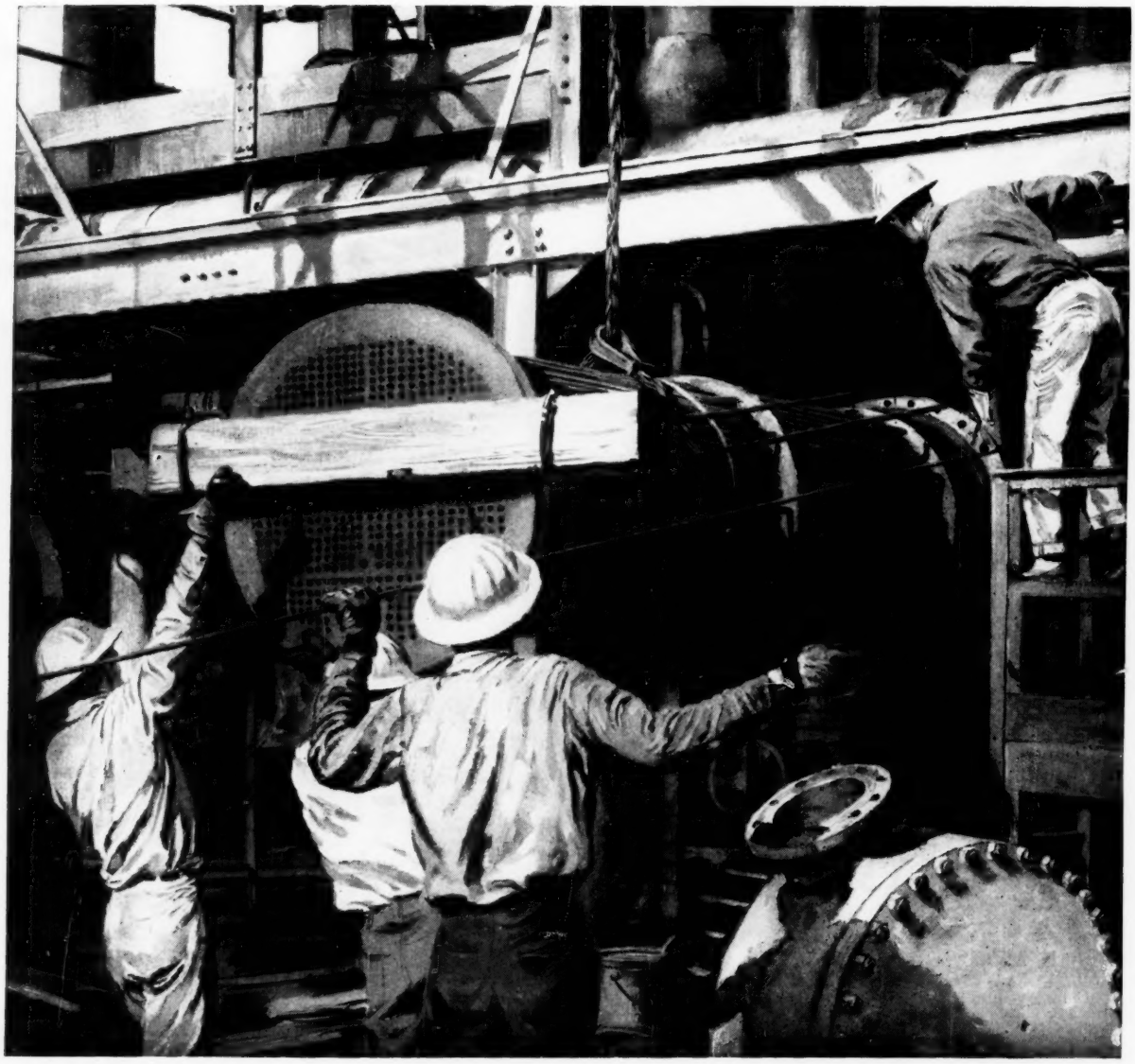

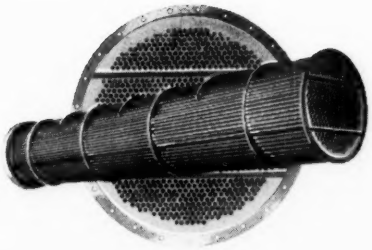

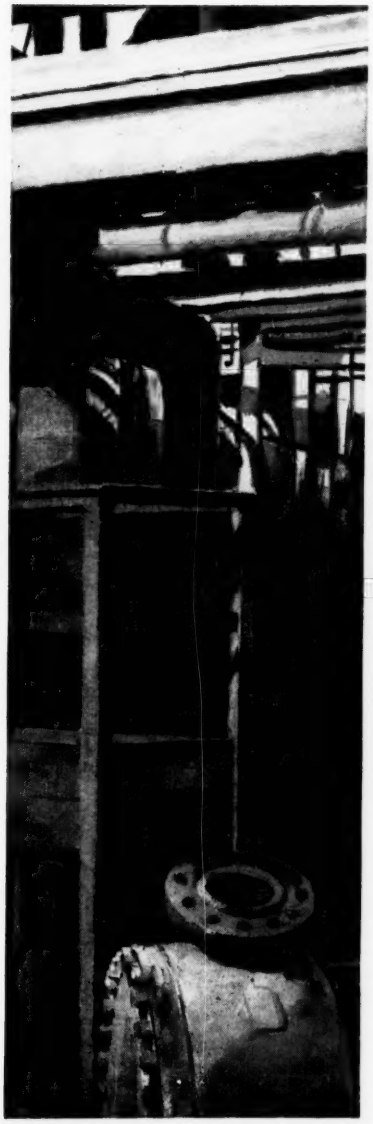

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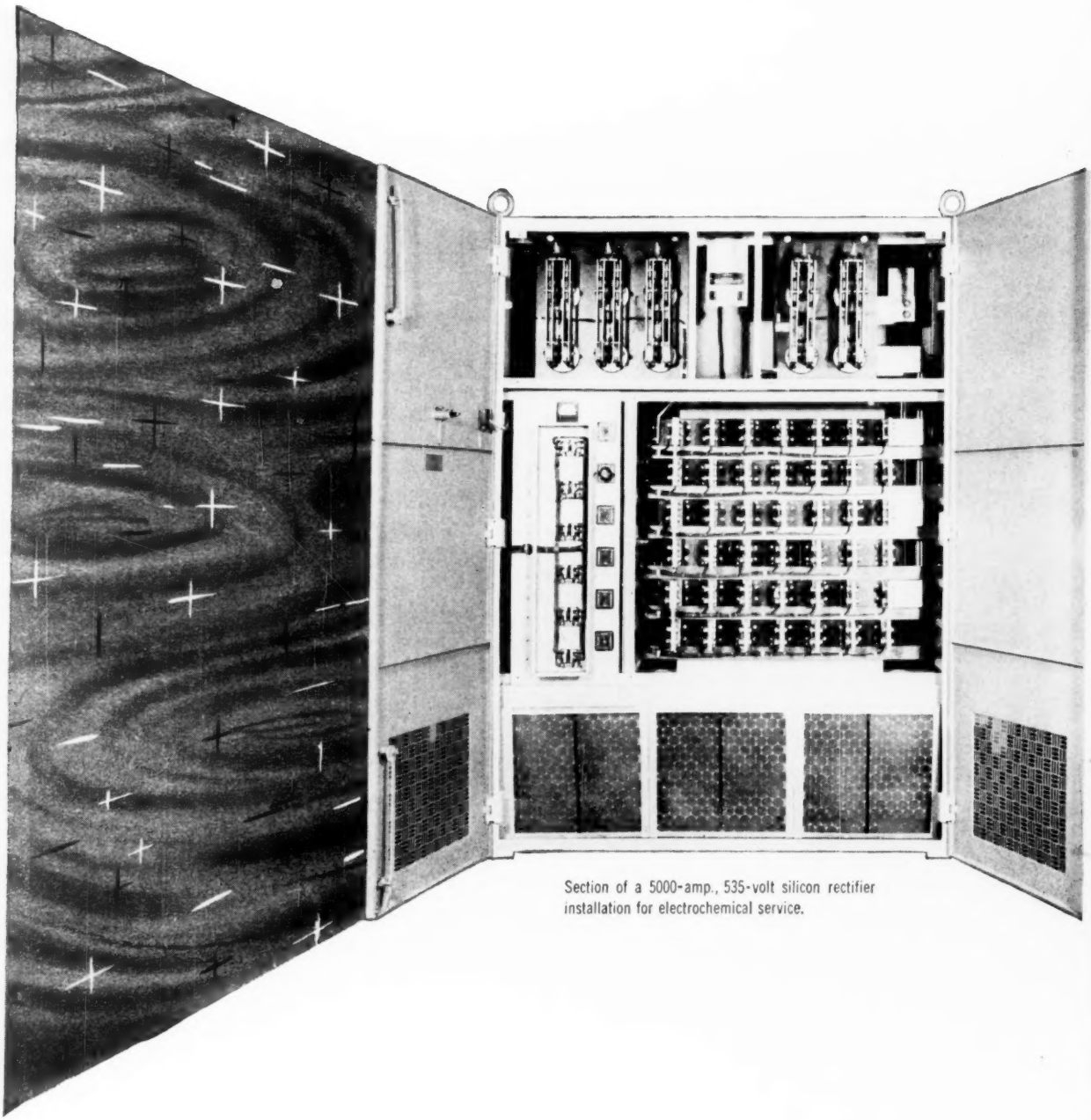
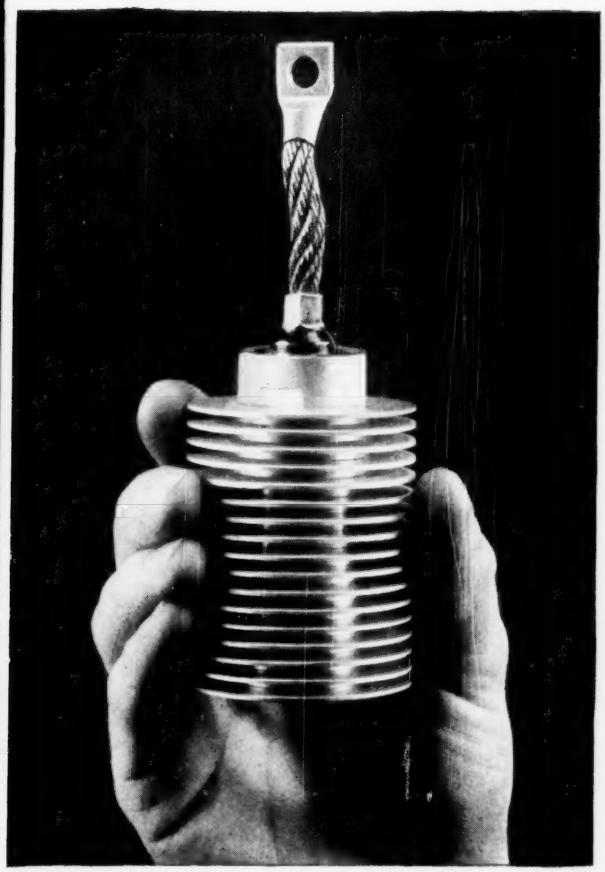


Section of a 5000-amp., 535-volt silicon rectifier installation for electrochemical service.

for medium and low voltage

electrochemical processing economy



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as light as a wisp

Lightweight Hackney cylinders save freight... help you tackle higher shipping costs

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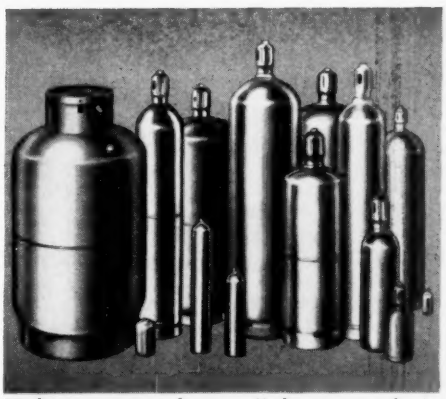

Hackney compressed gas cylinders are made in many sizes, for high-pressure or low-pressure shipment of all types of gases.

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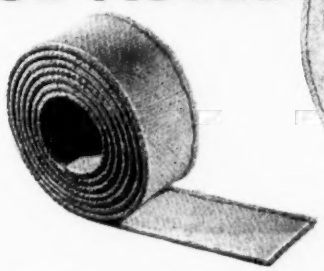
BLUE ASBESTOS Teflon† GASKETING



CHEMICAL INDUSTRY—Joints of piping handling strong acids are best sealed, at low cost, with Garlock Teflon-treated blue asbestos gaskets. Made of woven acid-resistant blue asbestos cloth, the open pores of which are filled with Teflon providing a strong, acid-proof, compressible gasketing.

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PRICE: Approximately $0.30 per pound, including heat treatment. Exact prices will be furnished on request.

-320°F.

SPECIFICATIONS: Lukens Nine Nickel is produced to meet ASTM A-353 and A-300 specifications. It is included in the ASME-UPV Pressure Vessel Code, Section VIII, 1956 edition.

-320°F.

PROPERTIES

Minimum tensile strength	90,000 psi.
Minimum yield strength	60,000 psi.
Elongation in 2 inches, minimum, per cent	22.0

Charpy impact tested in accordance with ASTM A-300 Specification down to −320° F.

-320°F.

COMPOSITION

Carbon, maximum, per cent	0.13
Manganese, maximum, per cent	0.80
Nickel, per cent, (approx.)	9.00
Silicon, per cent, (approx.)	0.30
Phosphorous, maximum, per cent	0.035
Sulfur, maximum, per cent	0.040

For dependable service to -320°F.

NINE NICKEL

for Low Temperature Service

-320°F.

FABRICATION: Normal in accordance with ASME Code. Lukens Nine Nickel has been welded with both manual electrode and inert gas shielded process.

-320°F.

AVAILABILITY: Lukens Nine Nickel is immediately available. The same prompt delivery is assured as with other Lukens alloy steel plates and heads.

HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB

MAIL THIS COUPON TODAY!

LUKENS STEEL COMPANY
227 Lukens Building, Coatesville, Pa.

Please send me complete information about Lukens Nine Nickel alloy steel for the following low temperature service: _____

NAME _____ TITLE _____

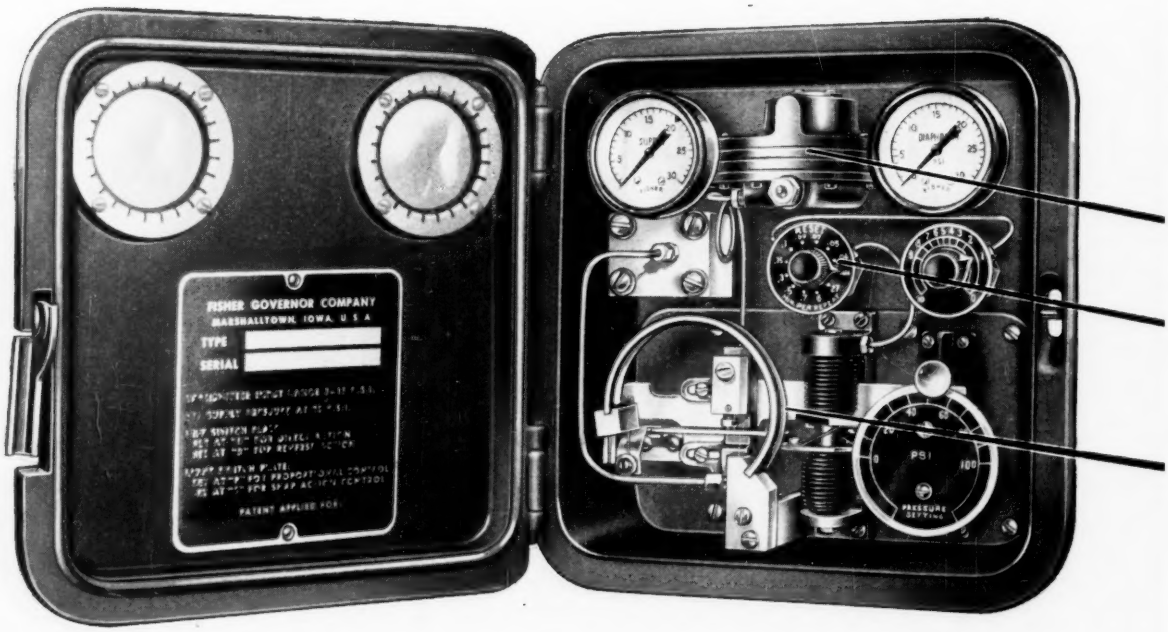
COMPANY _____

ADDRESS _____

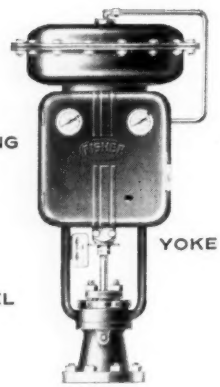
CITY _____ ZONE _____ STATE _____

LUKENS ®

Basic Simplicity...faster



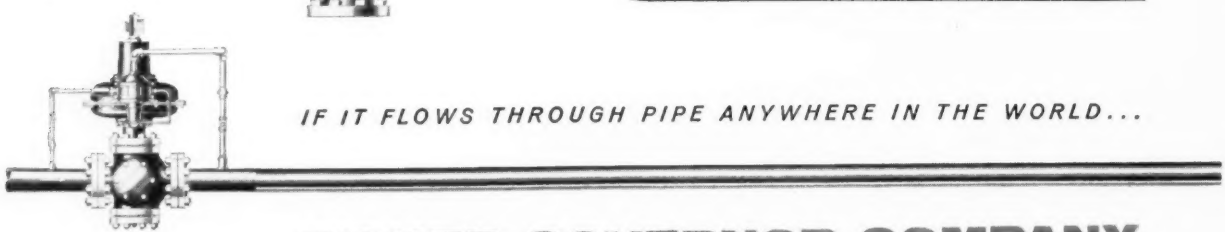
SURFACE MOUNTING



YOKE MOUNTING

FLUSH PANEL MOUNTING

PERFORMANCE DATA	
Test	**Results**
Air or Gas Consumption with 15 psi Output Pressure	Minimum at 10 or 0 Proportional Dial Setting—2 cfh Maximum at 5 Proportional Dial Setting—23 cfh
Resolution Sensitivity	Minimum Change Required in Measured Variable to Produce an Effective Movement of Final Control Element is 0.1% of Bourdon Tube Rating.
Repeatability	Ability of Wizard to Reproduce Its Output Signal for a Given Pressure Setting is 0.5% of Bourdon Tube Rating
Resonant Frequency	Unaffected at Usual Motor and Turbine Speeds.
Temperature Effects	Under Cold Box Test at —20° and Simulated Sun Test from 80° to 212°F Control Pressure Remained Within ±1% of Bourdon Tube Rating.



IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...

FISHER GOVERNOR COMPANY

response...greater stability

the **WIZARD II**
PRESSURE CONTROLLER
with New and Improved Features

1. **VOLUME RELAY** for faster response to pressure changes.

2. **RESET FEATURE** for greater stability and pin point control, assuring perfect metering, even on multi-stage meter runs.

3. **WIDE RANGE** brass, steel or stainless steel Bourdon tubes cover a range of from 25 to 10,000 psi. Bellows assemblies for low pressure regulation in ranges from 0 to 25 psi.

Again FISHER engineering produces features the industry needs to do a better job

The Wizard II has been designed to specifically meet the demands of modern, complex systems requiring closer control. The Wizard II retains all of the basic simplicity, accuracy and dependability of the Wizard 4100U, plus its own exclusive features.

The new design consists of two sub-assemblies encased in a weather proof die cast aluminum housing which is provided with a ¼" pipe threaded vent for gas service. Either assembly can be removed without disturbing line connections.

The upper assembly consists of two gauges, relay and proportional band adjustment. The lower assembly includes the set point adjustment, proportional bellows, Bourdon tube and nozzle. Each assembly is assembled and calibrated before mounting in the case. The case can be mounted on a flush panel, a wall or on the yoke of the control valve.

Careful and exhaustive tests have conclusively proved that the Wizard II measures up to rigid Fisher standards.

A completely descriptive and illustrated bulletin on the Wizard II is yours for the asking. Write for Bulletin No. D-4150.

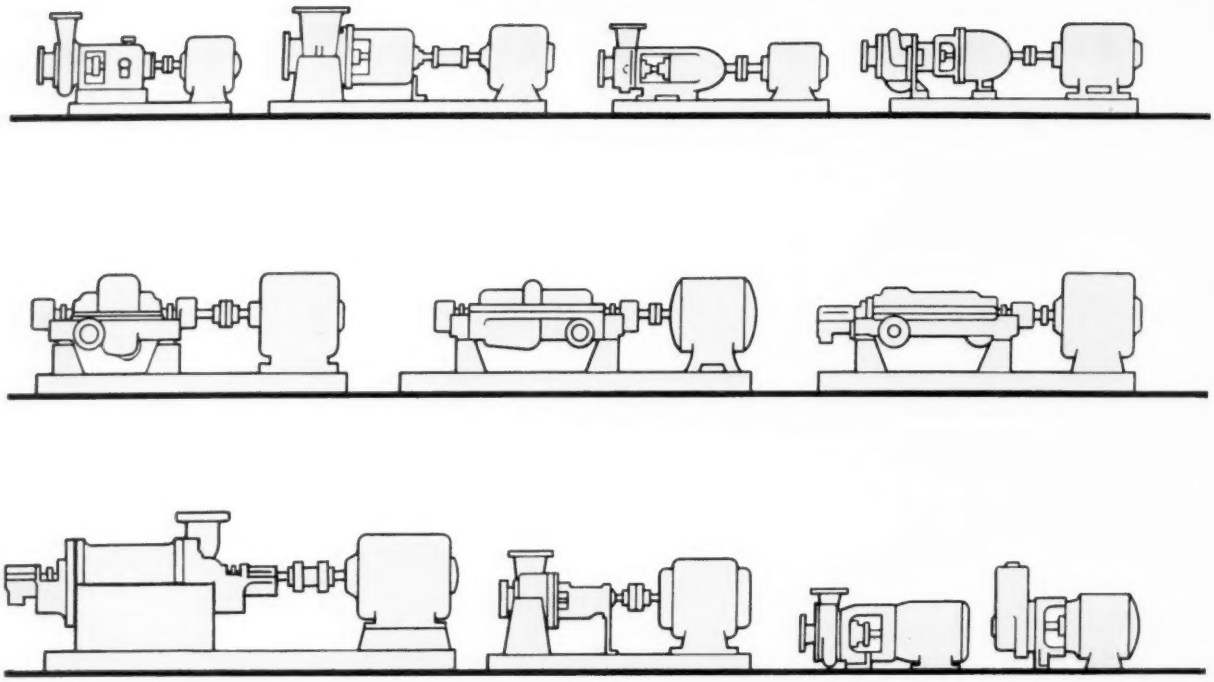
The original Wizard I is still available for those applications not requiring volume relay and reset features.

CHANCES ARE IT'S CONTROLLED BY...

FISHER® Controls

SINCE 1880

Marshalltown, Iowa / Woodstock, Ontario



Which one is the right pump for

The efficiency of your entire process can depend on the selection of the right process pumps... or even on a single pump.

Here are five questions you should ask yourself about pump manufacturers... know the answers before you select your next pump.

1 *Who has the most complete line?*

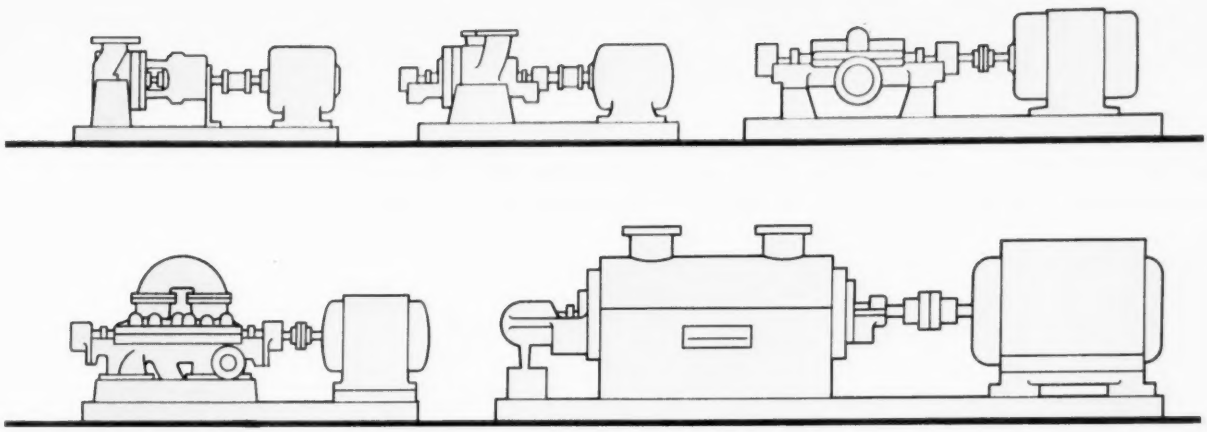
It's a fact that Ingersoll-Rand makes the most complete line of centrifugal pumps available from any single source. Often I-R is the only supplier who can quote on all the centrifugal pumps needed for a new processing plant. For that reason you benefit in two ways: The I-R engineer will be completely unbiased in helping you select the right pumps, and you get the advantages of *undivided responsibility* for all your pump requirements.

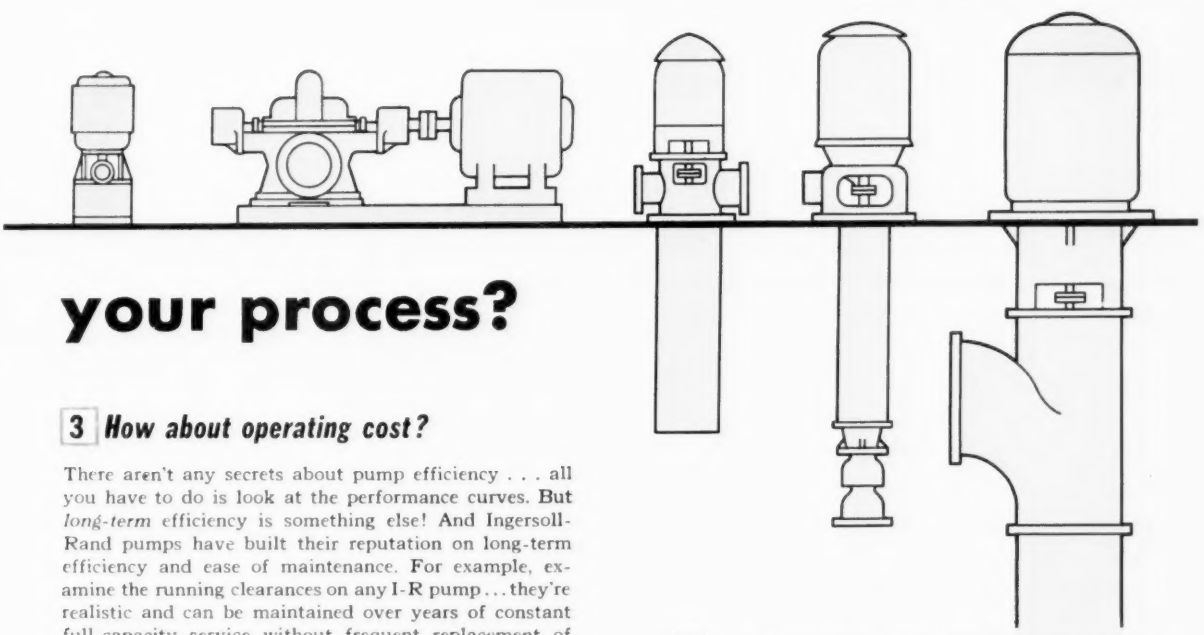
2 *What if I need a "special" pump?*

Despite the unequalled completeness of the I-R line (a few of the hundreds of types and sizes are sketched above), there are occasions when a standard pump won't do the job properly. Here's where Ingersoll-Rand's long experience pays off. If the right pump doesn't exist, I-R will build it! This is another reason why you're always sure to get the right pump for the job from I-R.

There's no substitute for

COMPRESSORS · PUMPS · DIESEL ENGINES · AIR & ELECTRIC TOOLS · TURBO BLOWERS · CONDENSERS





your process?

3 How about operating cost?

There aren't any secrets about pump efficiency . . . all you have to do is look at the performance curves. But *long-term* efficiency is something else! And Ingersoll-Rand pumps have built their reputation on long-term efficiency and ease of maintenance. For example, examine the running clearances on any I-R pump . . . they're realistic and can be maintained over years of constant full-capacity service without frequent replacement of wearing parts.

4 How about parts interchangeability?

The record speaks for itself . . . you can inspect and compare charts which spell out the degree of interchangeability of parts in each class of I-R pumps. I-R works constantly to standardize parts and thereby reduce your spare parts inventory.

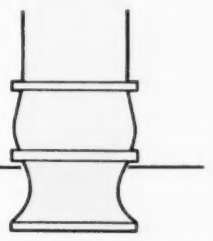
5 And how about engineering services?

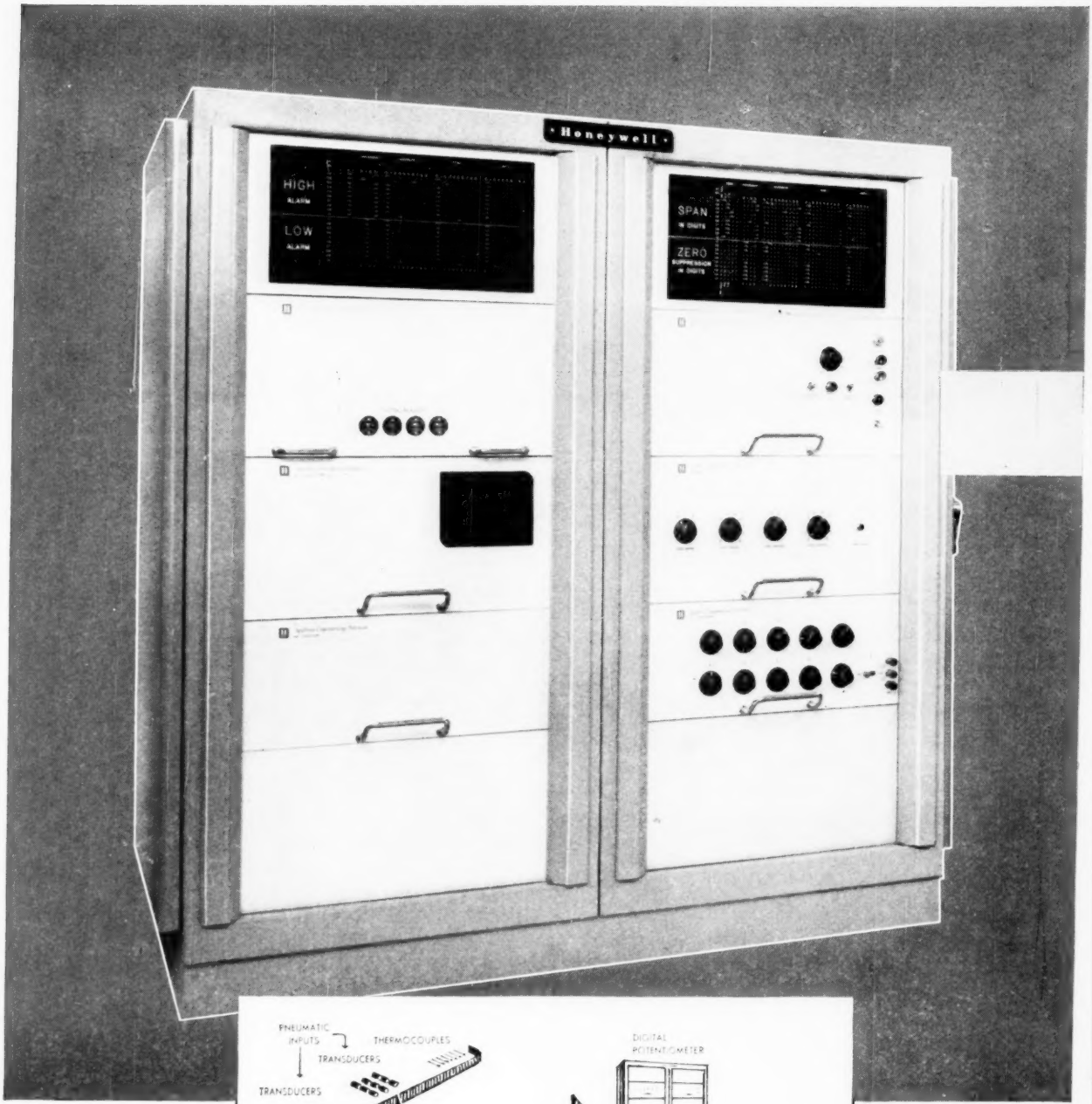
Without obligation on your part, I-R pump specialists will evaluate your process requirements and make constructive suggestions on pump selection. Elevation prints and performance curves will be provided to help you with mechanical and hydraulic design problems. Manufacturing that is coordinated with your requirements means that you get delivery when you want it. And Field Erection Service is always available, to assure proper installation . . . *on time.*

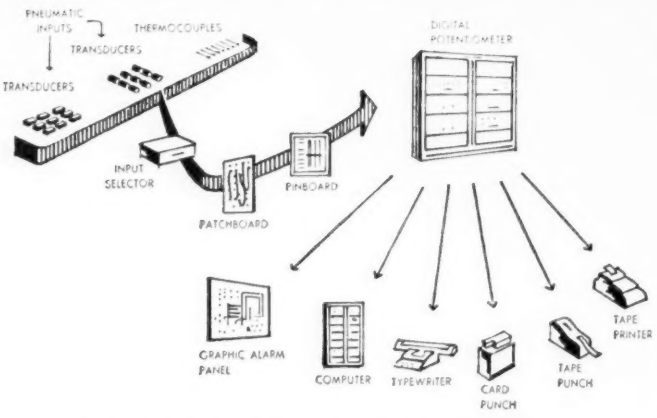
experience in engineered products

Ingersoll-Rand

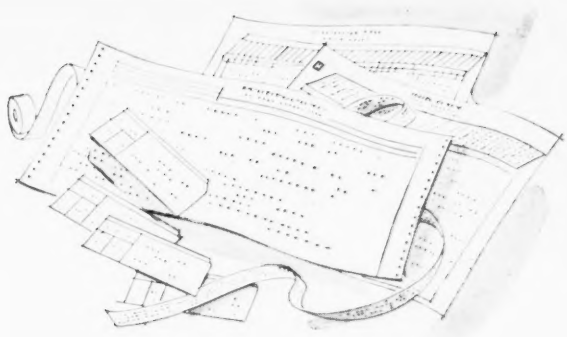
10-833 11 Broadway, New York 4, N. Y.







Data Handling System measures input signals—temperature, pressure, flow or other variables—and translates them into digital form on any of the types of readout equipment depicted.



Centralize all your process data

. . . with this new Data Handling System

Puts complete production data at your fingertips

Honeywell's new Data Handling System gives a clear, complete picture of processing conditions every minute of the day—automatically. You can depend on it during process upset, when you need it most. It logs process variables quickly, accurately, completely—as it sees them, without "fudging."

The Data Handling System supplies data on a typewritten log sheet and on punched cards or tape that can be used directly in business machines, saving the time and cost of transcribing data from operators' log sheets.

Before you consider *any* data processing equipment for your plant, learn for yourself all that the Honeywell Data Handling System offers. Write or call.

MINNEAPOLIS-HONEYWELL REGULATOR Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

FLEXIBILITY—Logging sequence can be changed at will . . . types and ranges of inputs are easily switched and added. Here's equipment that defies obsolescence—you can move it readily from one process to another.

DEPENDABILITY—All components are designed for remarkably long life and utmost operating efficiency . . . with maintenance needs pared to a minimum.

ACCURACY—Readout to within 1/10 of one percent, accuracy that's barely approached by other data processing equipment.

SIMPLICITY—Gone are the complexities you've long associated with data processing. Here's a system that's really easy to operate and maintain.

EASE OF SERVICE—The Honeywell Data Handling System can be serviced while in operation—an exclusive advantage.

Honeywell

H HONEYWELL First in Controls

EXPERIENCE — Successful completion of the spherical reactor, other new designs and customer projects are the responsibilities of C. S. Brown, Manager of Product Development, (at right) and E. E. Deuring, Director of Product Engineering. They coordinate all phases of mechanical and process activities to *exactly* meet your specific performance requirements.

ENGINEERING

a new look in reactors

Another Glascote first brings you higher pressures and vaporization rates, larger capacity plus superior glass lining

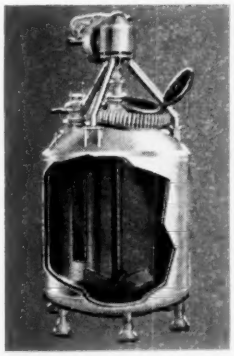
Because of Glascote's long service to the chemical processing industry, they foresaw the need for higher reactor pressures.

Heretofore, reactors could not offer the processing advantages of units capable of operating above the 200 psi ceiling. Glascote engineering accepted the challenge. They went to work . . . came up with tomorrow's design today . . . the first glass-lined spherical reactor.

What will it do? This revolutionary design makes possible internal operating pressures up to 330 psi . . . jacket pressures to 250 psi. *That's 130 psi over any existing reactor!*

This remarkable accomplishment was executed by what we consider the finest creative engineering group in the industry. And they have demonstrated their ability many times . . . by developing these engineering firsts: Rotary mechanical seal, double wall dip tube, welded sealer rings and many others.

Why not tell us about your design, process and application problems. We'll put the same kind of engineering effort and service to work for you.



If your present processing operations do not require higher pressures, you can get the same proven engineering that produced the spherical reactor in Glascote's standard and custom-built line of glass-lined reactors, columns, storage tanks, rotary dryer-blenders, heat exchangers, pipe and fittings and accessory items.

Glascote®
PRODUCTS, INC.

Cleveland 17, Ohio

Sales offices or agents in principal cities, Export sales:
A. O. Smith International S.A., Milwaukee 1, Wis., U.S.A.

A subsidiary of A.O.Smith Corporation
World's largest manufacturer of glass-lined steel products

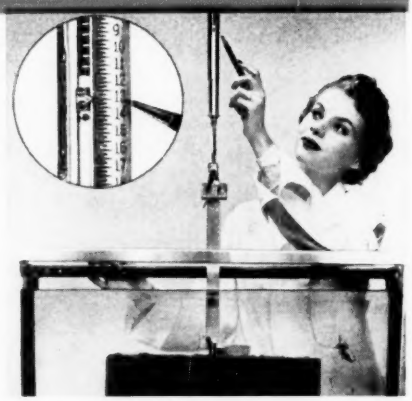
What's behind the Glascote sales engineer... and his glass-lined products?

— 38 years of Glascote experience in manufacturing glass-lined vessels and tanks for the process industries. Through continual research and development engineering, Glascote stays ahead of the demand for new and improved processes requiring a wider range of corrosion, temperature and thermal shock-resisting properties for glass linings.

In addition, Glascote gives you preventative maintenance help, in-plant seminars . . . specialized field service. Glascote is free to call upon the 83 years of accumulated research, engineering and manufacturing experience of A. O. Smith Corp.

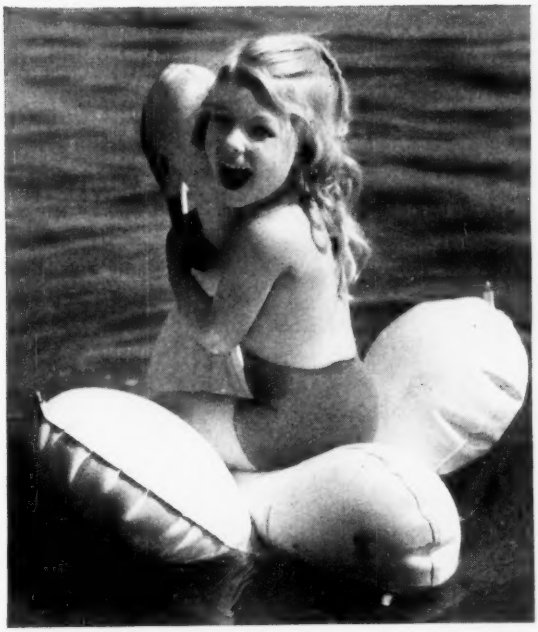
He's an experienced engineer who can give you on the spot product and process assistance.

Life on the Chemical Newsfront

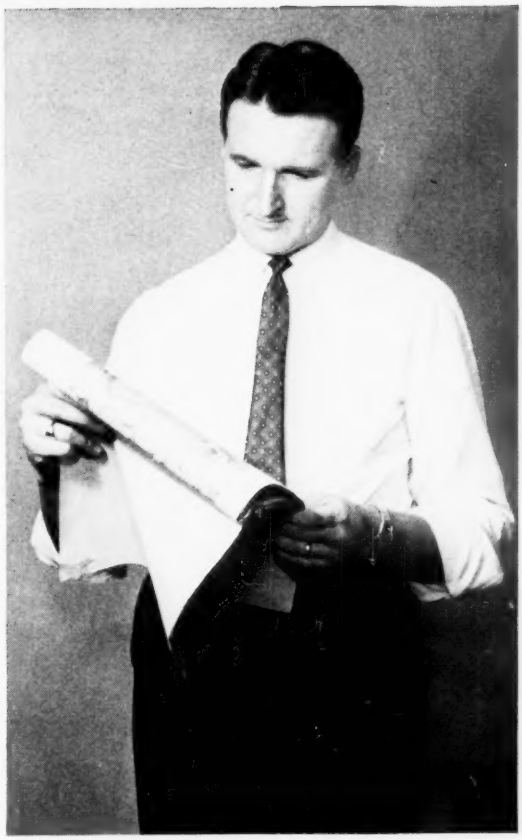


HIGHER WET STRENGTH IN PAPER can be secured with 30% to 60% less resin with Cyanamid's new HE (high efficiency) Process.† Intensive field tests have proved that the new HE Process not only provides unprecedented reductions in resin costs, it also makes possible the production of "super" wet strength papers with properties never before obtainable. Details of this process and its licensing can be secured through your Cyanamid Paper Chemicals Department Representative. (Industrial Chemicals Div.)

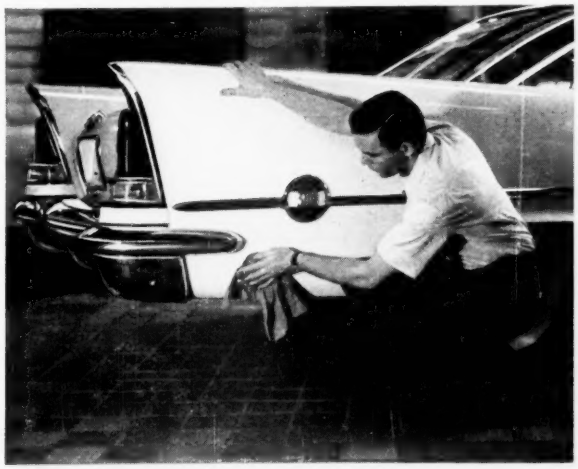
NEW RESINS GIVE EXCELLENT DURABILITY in the roughest application around the home—appliance finishes. Recently introduced CYZAC* *coating resins* offer an unusual combination of maximum hardness and scratch resistance with much greater impact and chemical resistance than other finishes. Baked CYZAC resin enamels also offer the high initial gloss and gloss retention that give that long-lasting "like new" appearance to appliances, metal furniture and cabinets. (Plastics and Resins Division)



WHITE RUBBER GETS "LIFE INSURANCE" from Cyanamid's UNITANE® *titanium dioxide*. Among the whitest pigments known, UNITANE is produced from materials that undergo thorough purification and careful quality control in manufacture to ensure maximum whiteness, high brightening strength and good aging characteristics. Longer-lasting whites and brighter pastels are assured in rubber and many other allied products by choosing one of the several grades of UNITANE titanium dioxide pigments. **(Pigments Division)**



WHITER WHITES ON SHARP UPGRADE. The strong trend to whiter whites—and brighter pastels—is evident in both paper and fabrics today, where CALCOFLUOR* *white fluorescent dyes* find increasing use. Papers upgraded by a small amount of CALCOFLUOR white look brilliantly white, more attractive, and also assure sharper halftone reproduction, as well as crisper, more legible printing. In cotton shirting, sheeting, and dress goods, CALCOFLUOR white counteracts yellowing of fabric, producing sparkling whites and clear, clean pastels. These CALCOFLUOR white brighteners are applied during paper or textile processing. In the finished product, they absorb ultraviolet light and re-emit it as visible light in the blue range of the spectrum. **(Organic Chemicals Division)**



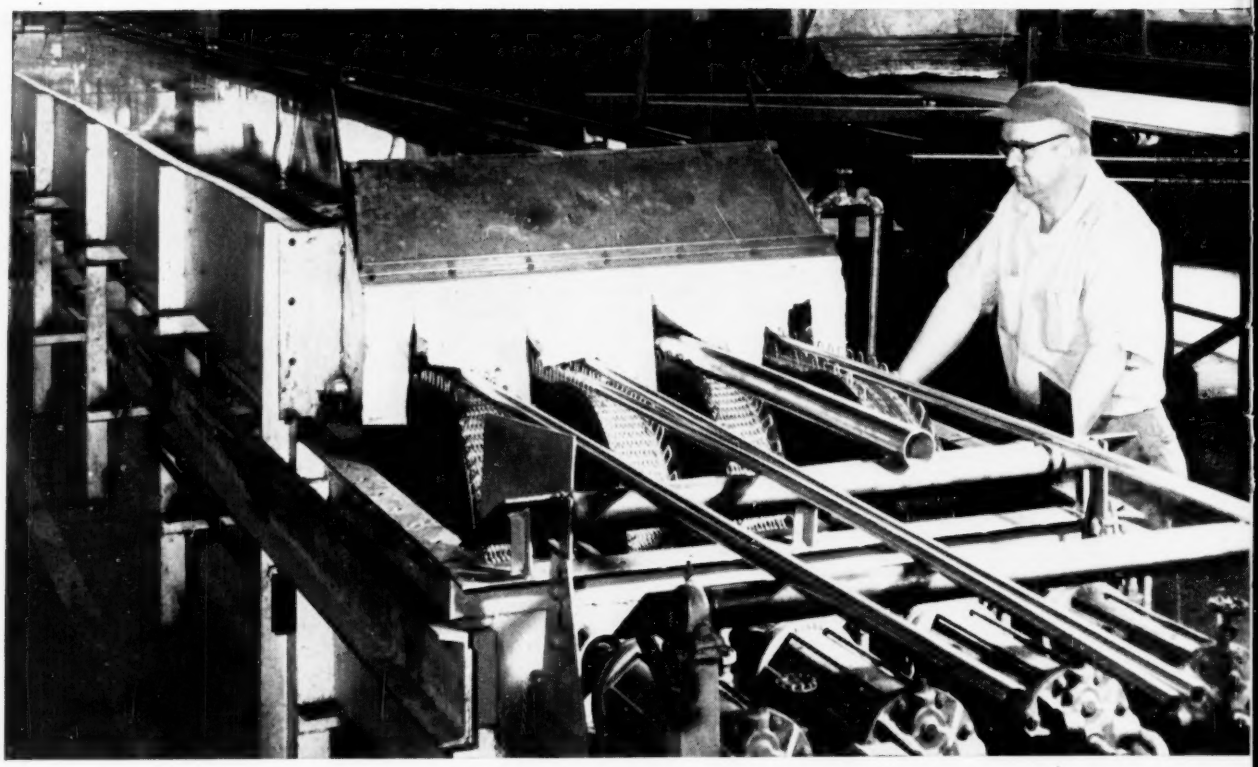
3-METHOXYPROPYLAMINE EXCELS in emulsifying agents for non-rubbing waxes and polishes. After the wax or polish is applied, 3-methoxypropylamine evaporates to deposit an irreversible glossy film of excellent water resistance. Both Fischer-Tropsch mineral waxes and emulsifiable polyethylene waxes lend themselves to this application. 3-methoxypropylamine can be used in much lower concentration than many other emulsifying components with equal or greater effectiveness. A data sheet outlining the use of 3-methoxypropylamine in waxes will be sent to you on request. **(Market Development Department)**

*Trademark
†Patent applied for by American Cyanamid Company

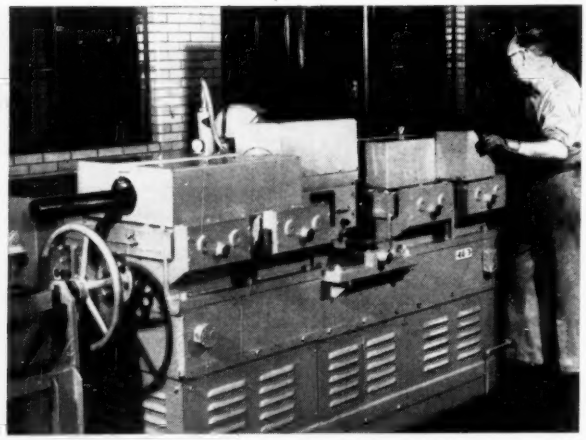
CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company



Bright Annealing Preserves Dense, Lustrous Surface of ELECTRUNITE Stainless Steel Tubing



FARROWTEST® is the best in non-destructive tests for tube irregularities. Tube moves through a group of test coils. The signal from these coils remains constant as long as tube is uniform and defect-free. Only Republic offers this electronic "eddy current" type non-destructive test. And it's available at the same cost as regular hydrostatic testing.

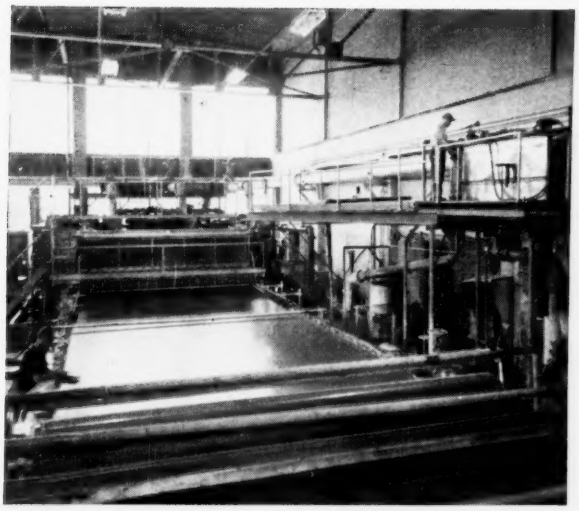
Here's news for every processor who needs stainless steel tubing and pipe with a dense, lustrous finish on both I.D. and O.D. Republic Steel and Tubes Division's new continuous bright annealing process produces a tube with a hard, high-quality finish in sizes from ¼" to 4" O.D. No scale is formed and no etching acid pickling is required.

Laboratory measurements show this finish to be smoother than ordinary pickled and open fire annealed tubing and pipe. This surface tends to resist build-up and caking of solids in piping and heat transfer equipment.

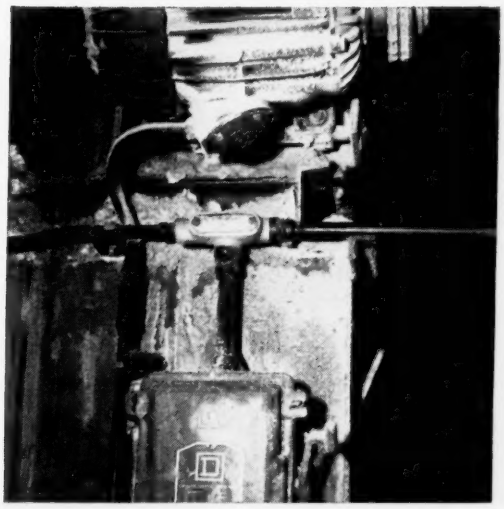
For many sanitary tubing applications, this bright annealed finish can be put into the line with no further polishing. Where further processing may be required, this bright surface cuts polishing to a minimum.

As in all of Republic's full line of stainless tubing and pipe, bright annealed products are produced from flat-rolled ENDURO® Stainless Steel, cold formed into tubular shape and joined by the "inert-arc" welding process. Every foot is uniform in wall thickness, of uniform diameter, and meets every requirement called for by ASTM and ASME specifications. Every foot reflects the skill and experience of the world's leading specialty tube maker.

Send coupon for more information on reducing your tubing costs with ELECTRUNITE bright annealed Stainless Steel Tubing, or call your Republic ELECTRUNITE representative.



OPERATING AND MAINTENANCE ECONOMY. Allied Paper Corp., faced with the common industry problem of high operating and material costs and the danger of losing a batch of quality stock due to inclusion of contaminating matter, inaugurated a conversion program. Older equipment is being replaced with stainless steel, making possible extreme cleanliness and safeguarding product quality. Although the program of replacing with stainless is only partially completed, Allied is already enjoying a 50% reduction in their weekly clean-up and maintenance time.



CUT ELECTRICAL RACEWAY MAINTENANCE COSTS. In this pulp mill, Republic Dekoron®-Coated Electrical Metallic Tubing resists corrosive action of fumes and steam. This easily-installed electrical raceway gives double protection of polyethylene coating over a galvanized finish. Moisture-tight, corrosion-protected joints are made by wrapping threadless connectors and couplings with plastic tape. Send for free booklet with complete facts and data.

TRUSCON "BUDGET BUILDINGS" offer ideal, top-utility housing at lowest cost. Available for immediate delivery in widths of 32, 36, 40, 44 and 48 feet—12- and 14-foot heights, in any length necessary. Orders filled from "off-the-shelf" stocks of pre-engineered materials. Roofing, siding, windows, doors, and hardware are shipped to the job site as a package. Learn more about Truscon "Budget Buildings", send for full-color brochure.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. CE-5282
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on the following subjects:

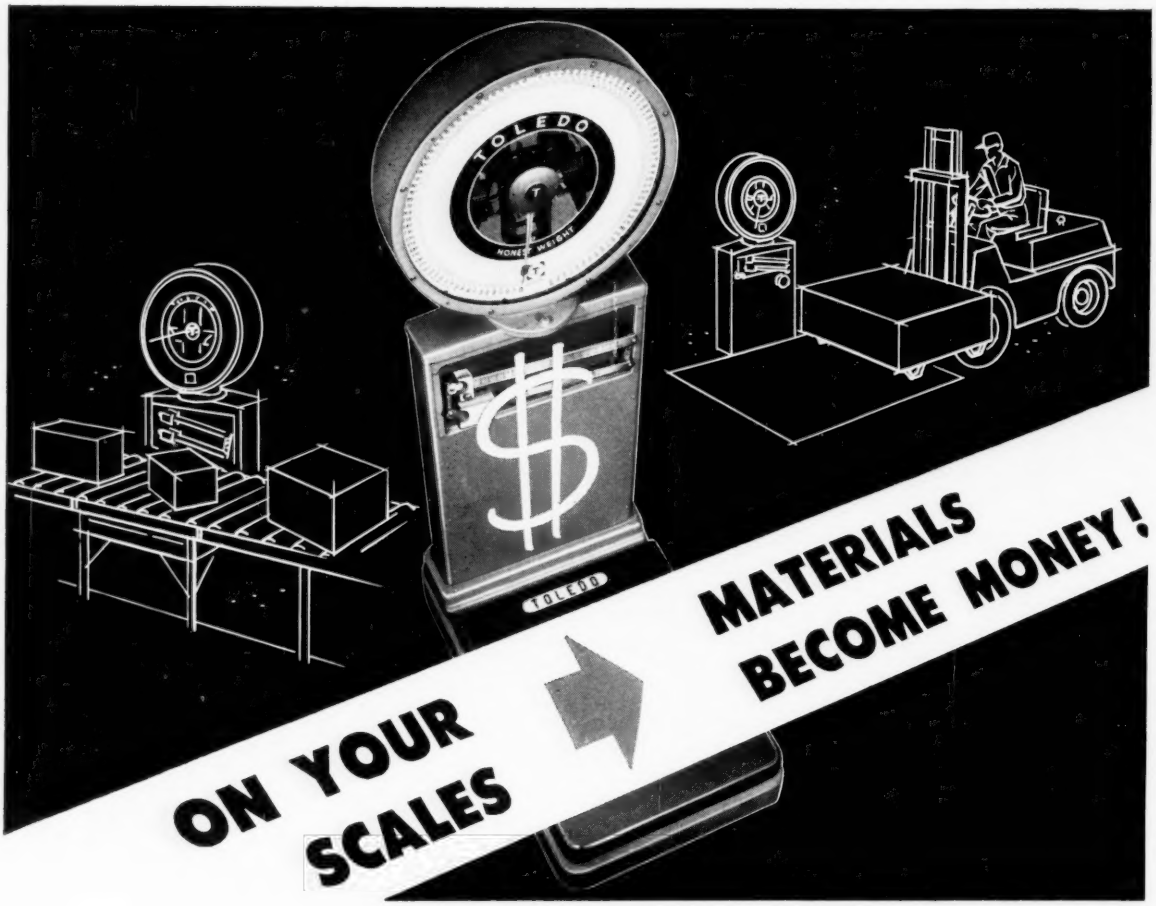
- ☐ Republic ELECTRUNITE Stainless Steel Bright Annealed Tubing
- ☐ Republic FARROWTEST
- ☐ Republic Stainless Steel Sheets
- ☐ Republic Dekoron-Coated E.M.T.

Name_____ Title_____

Firm_____

Address_____

City_____ Zone____ State_____



It will pay you to check up on weighing efficiency in your plant!

For proper cost control, efficient weighing is a prime requirement. Weight records directly affect costs, quality, inventory control and customer billing. You can avoid weighing errors and inadequate weight data by placing the right scales in the right places . . . all properly integrated in a *plant-wide weighing system* to supply basic accounting records on materials received, transferred and shipped. You can easily check up on the job your scales are now doing. Just ask for the exclusive Toledo Weight Fact Kit. A Toledoman will gladly explain how it will help you detect and correct weighing inefficiencies in your plant. REQUEST YOUR WEIGHT FACT KIT NOW. No obligation. Address Toledo Scale, 1403 Telegraph Road, Toledo 12, Ohio.

SERVICE Factory-Trained 200 Cities

TOLEDO SCALE

Headquarters for Weighing Systems

DIVISION OF TOLEDO SCALE CORPORATION

FLOOR AND TRUCK SCALES

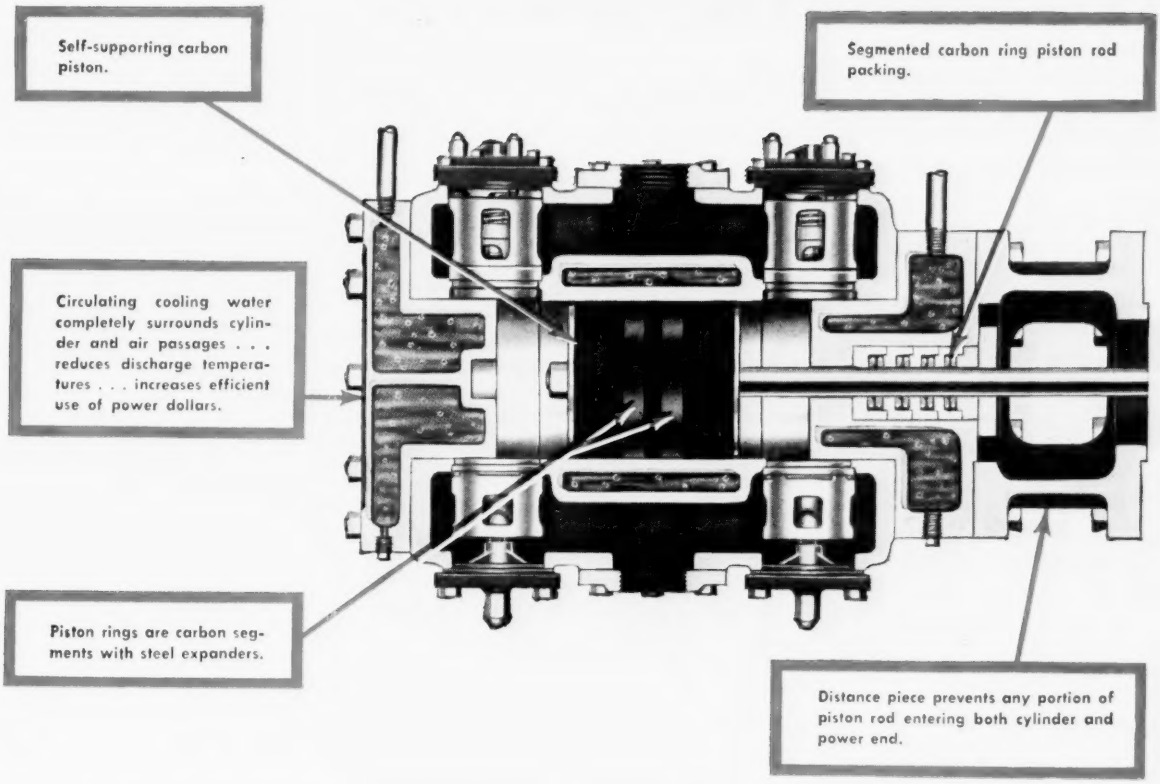
BENCH AND PORTABLE SCALES

OVER-UNDER SCALES

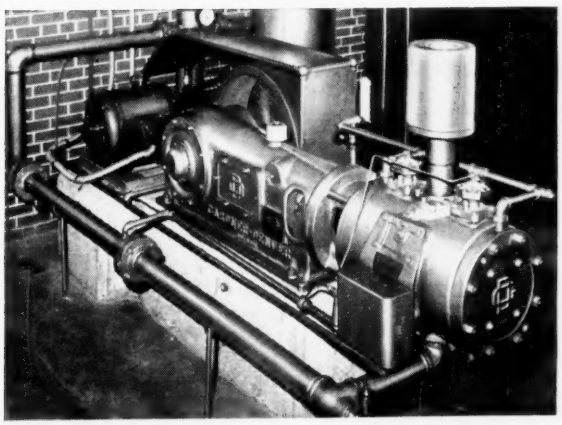
REMOTE DIGITAL WEIGHT RECORDING

OVERHEAD TRACK SCALES

COUNTING SCALES


Self-supporting carbon piston.
Segmented carbon ring piston rod packing.
Circulating cooling water completely surrounds cylinder and air passages . . . reduces discharge temperatures . . . increases efficient use of power dollars.
Piston rings are carbon segments with steel expanders.
Distance piece prevents any portion of piston rod entering both cylinder and power end.

Guard your product quality with low-cost, oil-free air



The Gardner-Denver CRX provides low-cost, oil-free air to help insure product quality. Costs no more for operation and maintenance than an ordinary compressor.

Here's an easy, low-cost way to protect your product quality from oil and other foreign matter in compressed air. Hook up a Gardner-Denver CRX carbon piston air compressor. This highly efficient unit delivers an abundance of low-cost, oil-free air—yet costs no more to operate than an ordinary compressor.

The CRX is widely used to supply air for special equipment in instrument control, food processing, brewing, distilling or the manufacture of plastics, chemicals and other products.

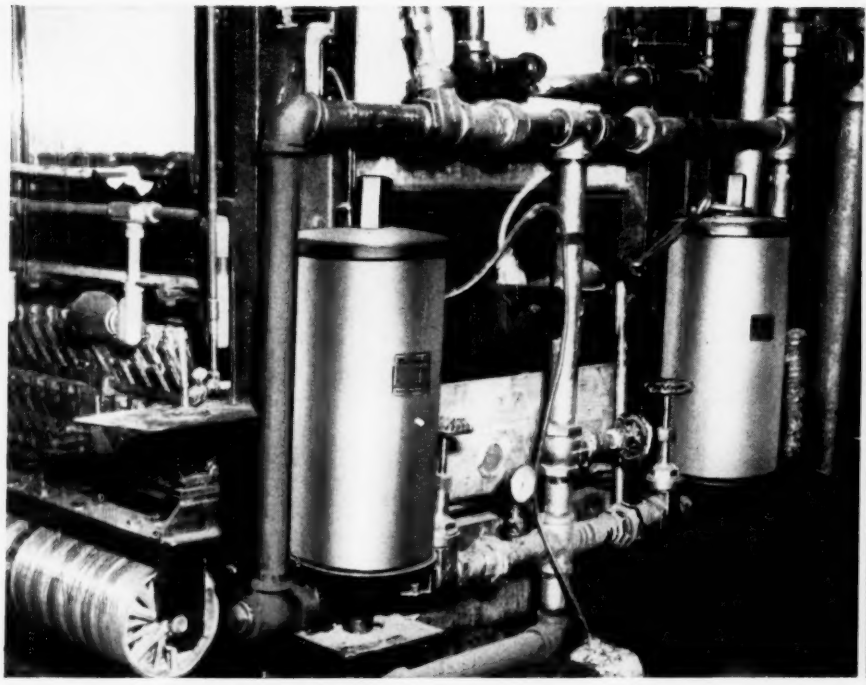
The Gardner-Denver CRX uses no oil in the cylinder. The pistons, piston rings and rod packing are all made of self-lubricating carbon. For added protection, an extra distance piece between the cylinder and frame prevents *any part* of the piston rod from entering both the power end and the air cylinder.

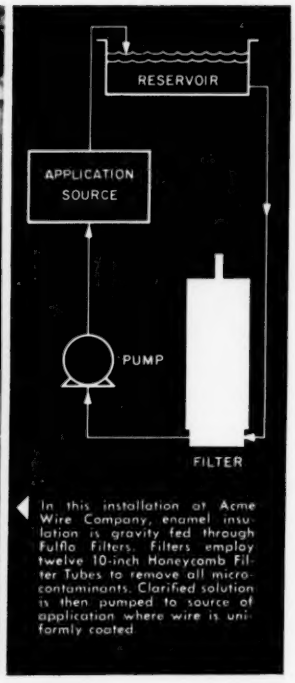
Gardner-Denver engineers will gladly help you select the right CRX to meet your particular requirements. Sizes available from 100 to 1410 cfm. piston displacement, for pressures from 15 to 150 psi. Write for Bulletin CRC-10.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario





In this installation at Acme Wire Company, enamel insulation is gravity fed through Fulflo Filters. Filters employ twelve 10-inch Honeycomb Filter Tubes to remove all micro-contaminants. Clarified solution is then pumped to source of application where wire is uniformly coated.

Fulflo Filters help insure quality of insulation for Acme Wire . . . . . .

Here's how Acme Wire Company of New Haven, Connecticut, uses Fulflo Filters to keep wire insulating compounds free from micro-contaminants.

Increasing demand for smaller armatures and coils has resulted in the development of magnet wire with exceedingly fine diameters. These call for even thinner coatings of insulation — which must meet higher and higher standards of protection. Such quality calls for absolute purity of insulating compounds. Fulflo Filters, with genuine Honeycomb Filter Tubes, remove all contaminants, such as fine copper dust, down to the incredibly small size of 1 micron. In this way, Acme assures its customers of uniform purity of insulation.

In addition to improving product quality, Fulflo Filters reduce downtime, prolong equipment life and increase production in a variety of operations. They provide any desired degree of micro-clarity for all types of industrial fluids: liquid chemicals; oils; water; liquid fuels; compressed air, CO_2 and other gases. Fulflo Filters give true *depth* (not just surface) filtration, at minimum pressure drop, for high or low flow rate, pressure, *p*H, temperature, and viscosity. Complete engineering facilities are at your service.

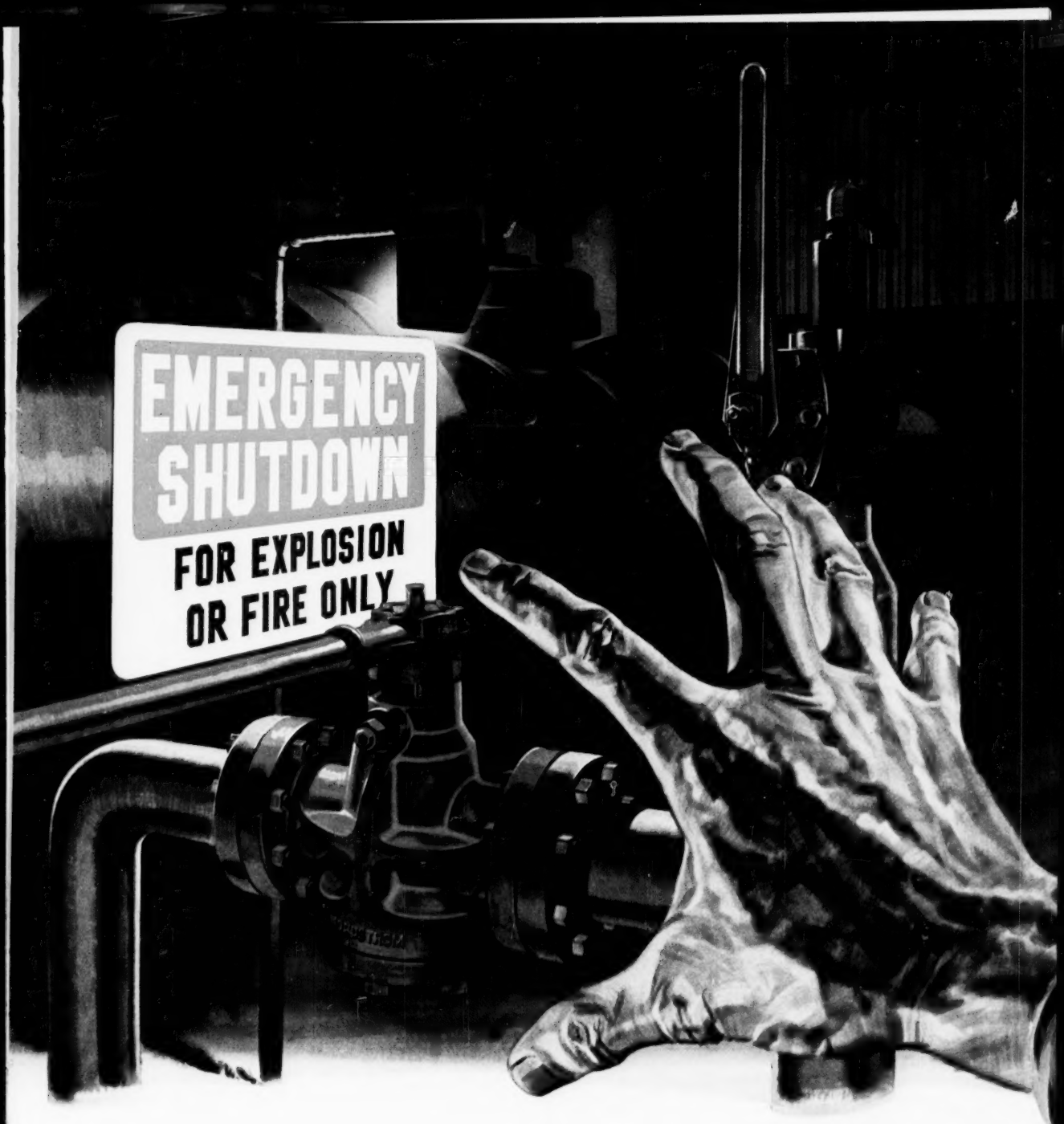
Write for new catalog to Department CE

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

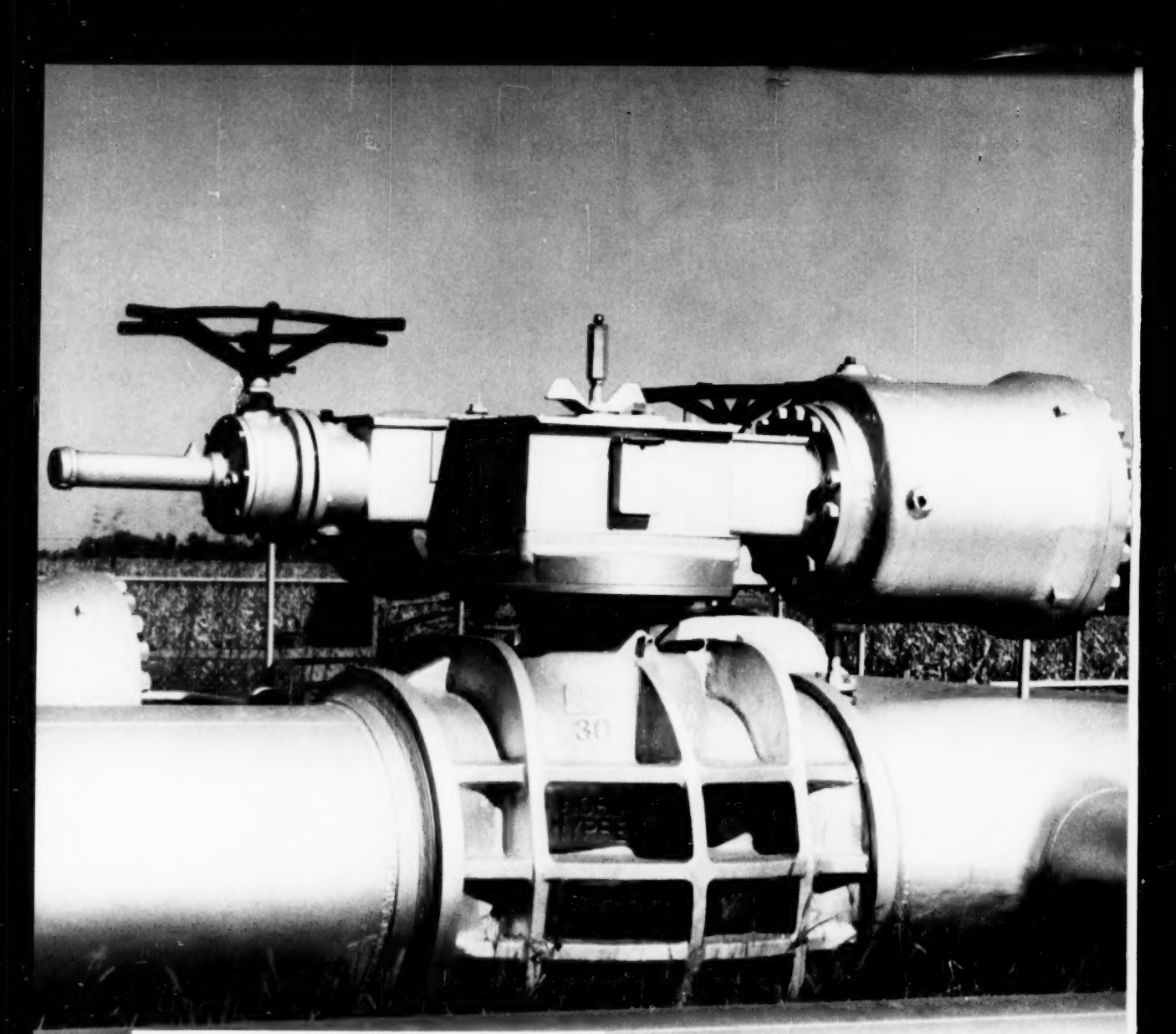
Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*



EMERGENCY VALVES never have a second chance . . . that's why so many of them are Rockwell-Nordstrom lubricated plug valves. The absolute dependability and positive shut-off that make these valves unequaled for the dramatic services are the same reasons why they will do a better job, longer and at lower cost, on routine services. Rockwell-Nordstrom is the world's most complete line of lubricated plug valves and plug valve accessories. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES
it's ROCKWELL
MANUFACTURING COMPANY



HOW FAST WILL IT CLOSE?

Rockwell-Nordstrom valves close much faster than ordinary valves . . . the *lubricated* plug moves only through 90° for *full*. positive shut-off.

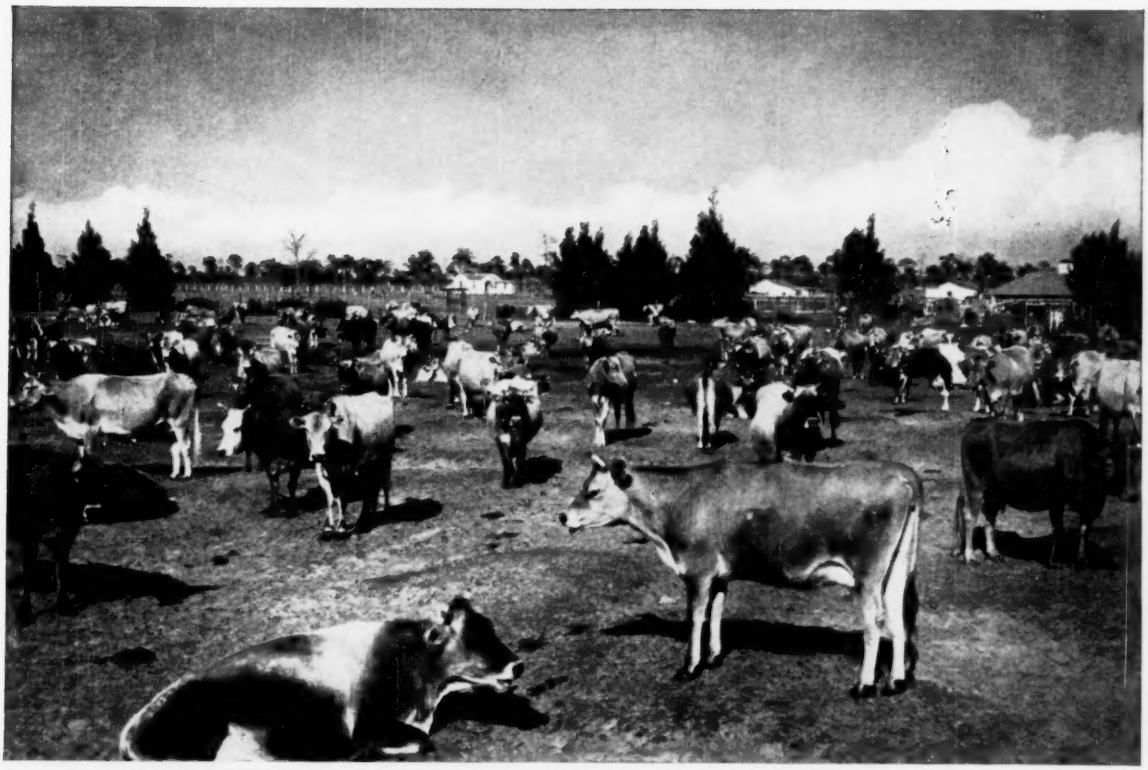
Rockwell-Nordstrom is the world's most complete line of lubricated plug valves and plug valve accessories. Rockwell Manufacturing Co., Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

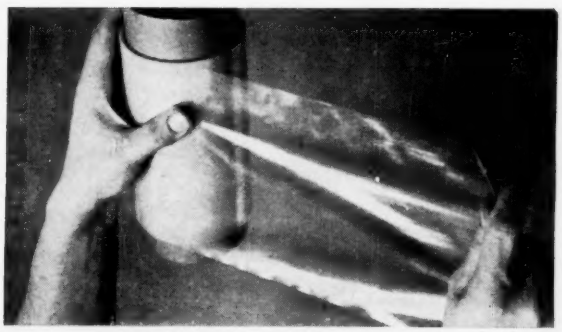
it's ROCKWELL

MANUFACTURING COMPANY

HOW *HERCULES* HELPS...



KEEP COWS CONTENTED—A number of Hercules ingredients contribute toward healthy, more productive livestock. Dalpac® BHT, for example, is a high quality feed antioxidant that promotes full assimilation of essential nutrients and protects vitamin potency. Hercules para-cresol is the basis for intermediates used in the production of growth stimulants and other pharmaceutical chemicals. Sprays based on Thanite® protect animals from annoying and often harmful insect pests.



PIONEER NEW PRODUCTS—Pro-fax*, Hercules' new polypropylene, makes transparent film with exceptional resistance to chemicals, oils, greases, and will withstand heats to 300° F. Rigid enough for use in overwrap machines, new Pro-fax films have excellent impact and tear strength and can be heat-sealed with conventional equipment.

UPGRADE FOOD FLAVORS—Monosodium glutamate from the Huron Division of Hercules is being used by an ever increasing number of food packers to enhance the quality of their products. MSG increases taste appeal—and sales—of a wide variety of processed foods.

*Hercules trademark

HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

G58-3

CHEMICAL MATERIALS FOR INDUSTRY

HERCULES

NEW VALVE-OLOGY

shuts off costly maintenance

Hancock 600# Steel Valves incorporate new concepts in valve-ology that reduce valve maintenance and equipment down-time. The forged steel bonnet and body have butting flanges so strong no distortion is possible. Compressed between them is a Flexitallic gasket so durable not even pressures exceeding ten times the rating of the valve can cause a blowout.

Hancock valve-ology makes full use of stainless steel to reduce your valving cost. Seat, disc, stem, swing bolts and nuts, thread bushing, packing gland follower—all are stainless steel. Globe, Angle, "Flocontrol", Lift Check, and Hi-Pressure Drop designs available. A high degree of standardization simplifies servicing and inventory needs. Your industrial supply distributor will gladly give you full details on Hancock Valve quality and performance. Phone him today.

Hancock 600# Steel Globe Valve. Type 5500 Line. Sizes: ¼" thru 2".

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

NEW! FULLY STANDARDIZED EXCHANGER OFFERS UNPRECEDENTED FLEXIBILITY

down go costs and delivery time for the process industries

It's here . . . the most versatile heat exchanger ever developed for the chemical industry — the Ross C-100. Of quality construction throughout, it is pre-engineered and fully standardized, by-passing high costs and delays inherent in custom fabrication.

Readily assembled to handle any combination of liquids and gases, the C-100 can be used as a heater, cooler, condenser or vaporizer for hundreds of process applications.

Extreme flexibility predominates . . . in materials, sizes and arrangement of components, mounting position, tubeside passes, nozzle orientation. Your choice is virtually limitless in meeting a tremendous range of conditions.

Want specific details? New illustrated Bulletin 302.5K1 will bring you all the facts on design, materials, sizes and adaptability. Send the coupon for your copy.

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Please send your new illustrated Bulletin 302.5K1 fully describing the Ross Type C-100 Heat Exchanger.

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Blowers and exhausters for
diversified industrial applications.

Standard models promptly available.

Clarage builds air handling and
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concentrated know-how!

When you want equipment designed
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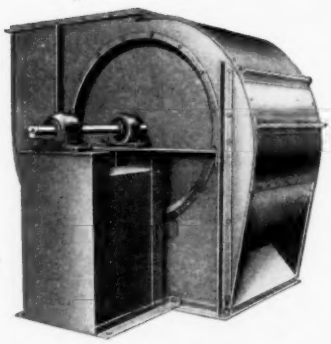
to stretch your equipment dollar
to the utmost — call on
CLARAGE FAN COMPANY, Kalamazoo, Mich.



CLARAGE ... *dependable equipment for making air your servant*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

your Aloyco sales engineer has only one business...

stainless steel valves

Your Aloyco sales engineer is a specialist... he handles only one line. You, as an Aloyco customer, deal directly with a man who knows his product and its application. He is equipped to get close to your problems and you'll find that this closeness to our customers goes right back to the Aloyco Plants. Doesn't it make sense to depend on the man and the company that specialize in corrosion resistant valves exclusively?

ALOYCO 503 Globe Valve... retained bonnet gasket... bolted bonnet... OS&Y... renewable Teflon disc fully retained. The Aloyco Valve line includes a wide range of alloys, types, sizes, and pressures of 150 lb, 300 lb, 600 lb and above. Nuclear Valves up to 2,500 lb.

ALLOY STEEL PRODUCTS COMPANY
Linden, New Jersey

Longer Lasting
ALOYCO
VALVES
1ST IN CORROSIVE SERVICE

The Arithmetic of Materials Handling

Fuller Airveyor unloads wood flour to two forty-five foot silos. Second Airveyor system reclaims material 360 feet to processing.

General Electric Changes From Bags to Airveyor . . . Cuts Handling Costs 60%

As part of a program to increase plastics production and reduce operating costs at its Pittsfield, Mass. plant, General Electric Company called in Fuller engineers to design systems for handling wood flour in bulk.

Wood flour—used as a filler in phenolic molding compounds—was being handled in 75 and 100-pound bags. Unloading one carload of bags required 16 manhours. Bags were loaded on dollies and wheeled to a distant elevator.

SAFETY FIRST—The two pneumatic Airveyor® materials handling systems, engineered and manufactured by Fuller Company, were installed by its parent company, General American Transportation Corp., providing undivided responsibility. This installation resulted in a 60% saving in handling costs! The two systems are handled by one full-time and one part-time operator. Manhours to unload one car have been reduced from sixteen to six!

In addition, all equipment is designed to conform to strict safety specifications set down by G-E engineers.

FLOW *YOUR* MATERIALS—The Airveyor is a system that flows your material through sealed pipes. It's fast, safe, and self-contained. The pipes can be placed close to ceilings, run underground or through walls.

Whether you process wood flour—or other dry granular materials—look into the many economies of Airveyor conveying. Write today for interesting, detailed literature on Airveyor and other Fuller pneumatic materials handling systems.

FULLER COMPANY GENERAL AMERICAN TRADE MARK

Fuller
....pioneers in harnessing AIR

FULLER COMPANY
134 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

G-196
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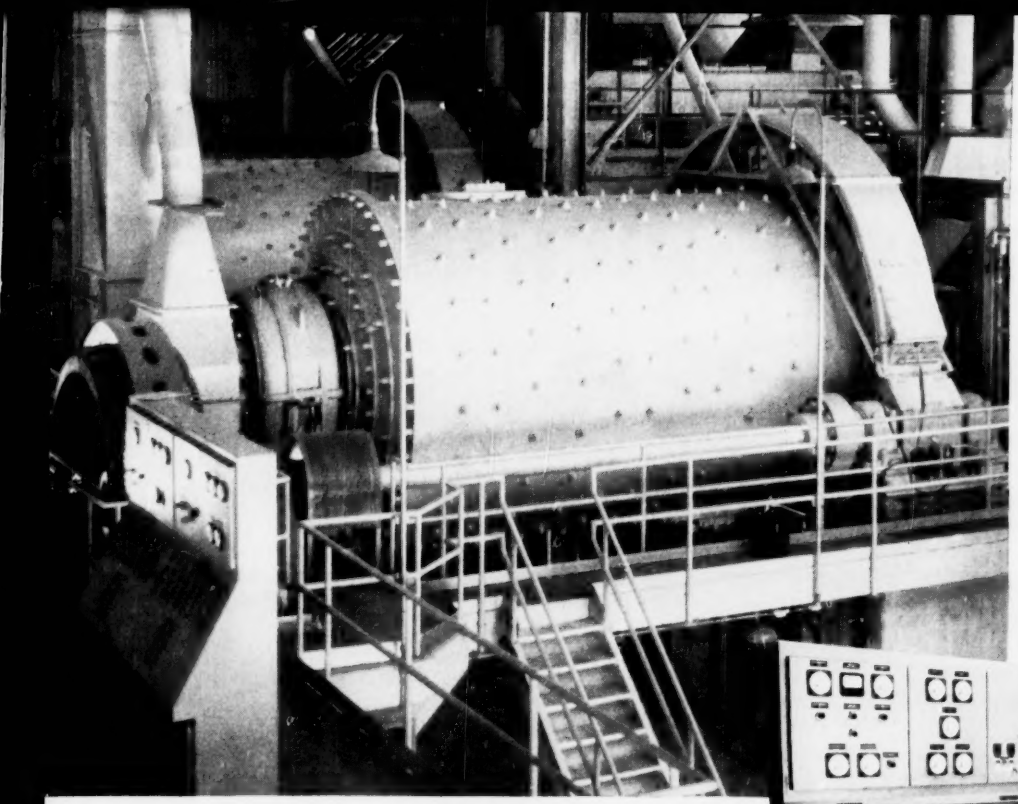
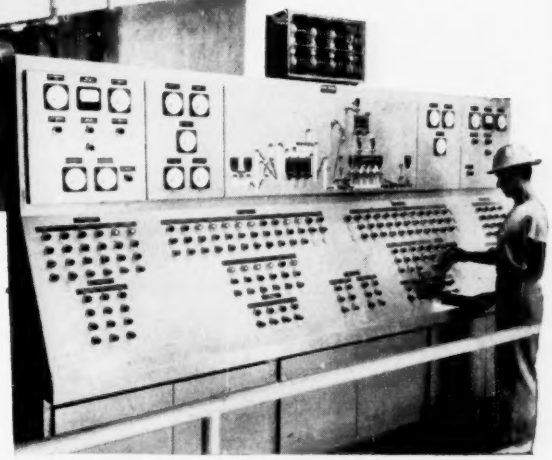
"See Chemical Engineering Catalog for details and specifications".



Left: Two of five 11′ x 17′ Nordberg Grinding Mills installed for dry process service at a new cement plant.

Below: Close-up view showing modern, functional Nordberg grinding mill control console, with interlocking relays for sequence starting of all equipment. Note flow diagram with indicator lights at center of top panel.



3 reasons why it pays to specify NORDBERG GRINDING MILLS

1 **Advanced Engineering** Nordberg mill design reflects significant technological improvements that may measurably affect your installation and operating costs. Sealed trunnion bearings; positive bearing lubrication; optimum life of wearing parts are among the features that will benefit you.

2 **Quality Manufacture** Nordberg Mills are (1) precision built to rigid specifications in shops renowned for (2) skilled manufacturing personnel, and (3) modern machine tools and equipment to assure quality workmanship. Good reason why the name NORDBERG has always signified the *ultimate* in mining, quarrying and process machinery.

3 **Dependable Operation** A team of experienced application engineers with a sound understanding of your milling operations qualifies Nordberg to serve you. More important, it assures you of the right machinery for the job . . . machinery that must be dependable and will continually produce to your specifications.

Nordberg Grinding Mills are built to meet specified conditions for wet or dry grinding—in the manufacture of cement; the fine reduction of metallic and non-metallic minerals; and in numerous other processes where friable material must be comminuted to fine sizes at low cost per ton. They are available with grate, overflow or peripheral discharge . . . and are built in sizes from 6 feet to 13 feet in diameter and up to 50 feet in length.

Write for a copy of Bulletin 232, which describes the complete line of Nordberg Grinding Mills.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

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CP258

NORDBERG

NORDBERG MACHINERY

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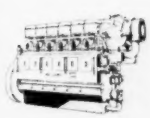
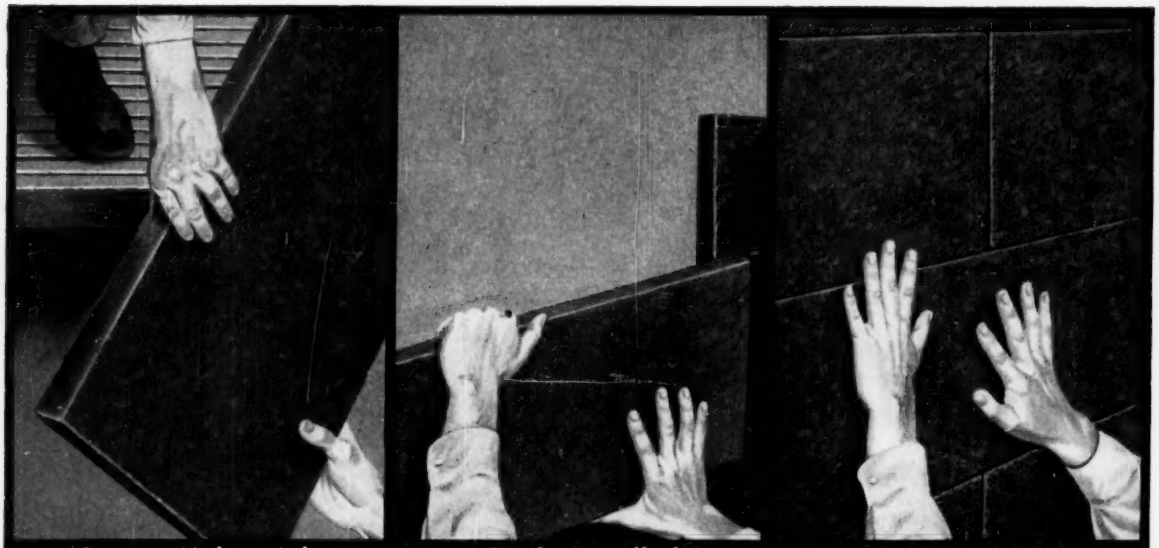


NORDBERG ENGINES to over 11,000 H.P.

A TRUE-CUT BLOCK WITH PRECISION-FINISH!

EAGLE-PICHER

PV SUPERTEMP
BLOCK INSULATION



Strong, Lightweight! *Easily Installed!* *Precision Finish!*

- Eagle-Picher's "precision-finish" is one of the most important insulation developments in years.
- Highly efficient, all-purpose block that is practically dustless.
- Great structural strength! Meets rigid demands for long-lasting block able to withstand wide temperature range up to 1900 F.
- Lightweight, easily installed! Easily cut to fit irregular areas—no special tools needed. Requires only minimum reinforcing.
- Effectively resists steam and other moisture! Does not disintegrate or lose thermal efficiency under heavy duty service.

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

FREE SAMPLE!

Write Today!

Eagle-Picher PV Supertemp Block conforms to Commercial Standard CS 117.

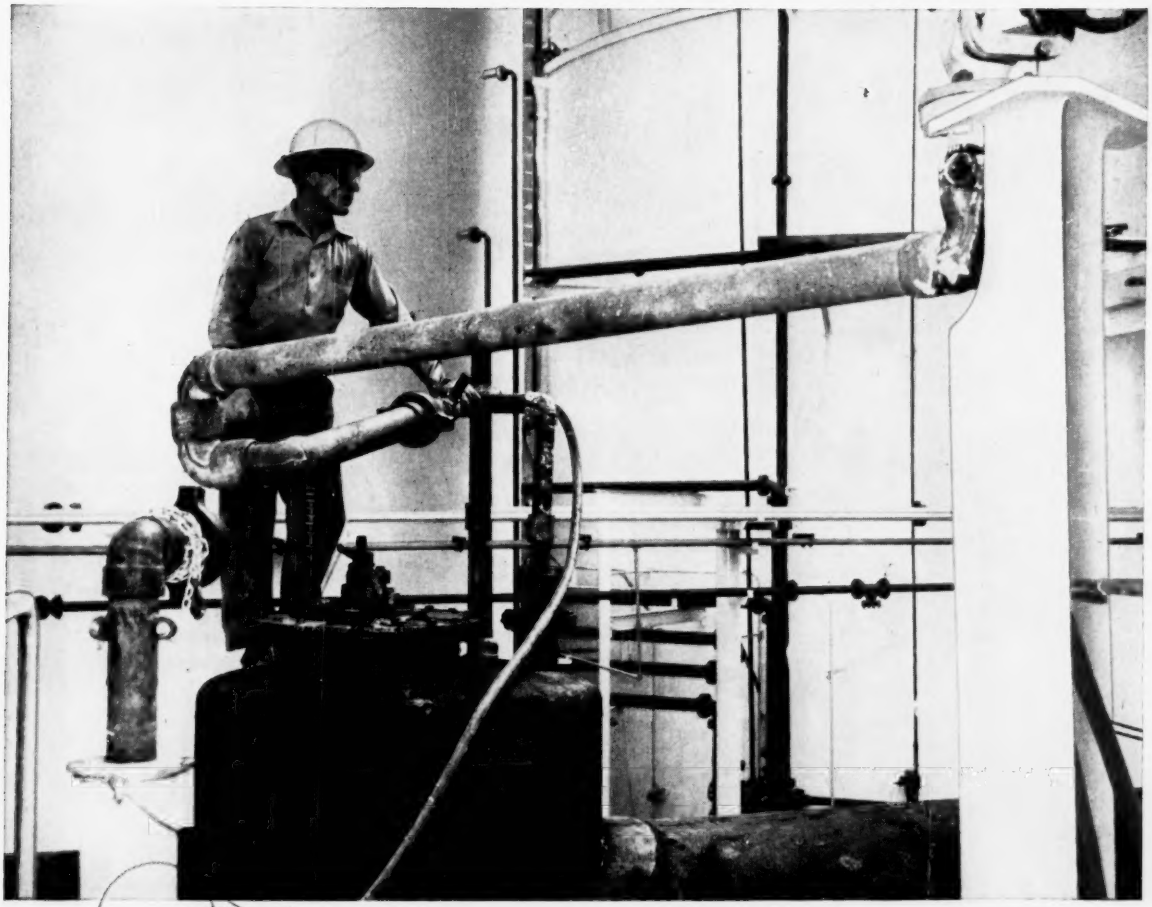
Since 1843

EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

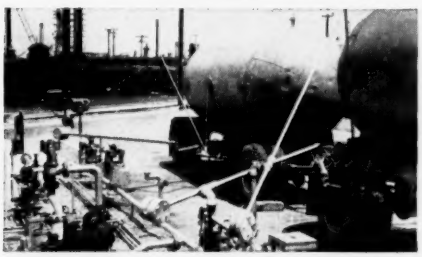


IN FLUID HANDLING—

CHIKSAN

LOADING ARMS

give hard-to-handle liquids a
SAFE SEND-OFF . . .



Chiksan Loading Arms deal with hard-to-handle corrosive chemicals, hydrocarbons, and other fluids and gases, speedily and safely, in all kinds of weather.

Chiksan Loading Arms, with their versatile ball-bearing swivel joints, combine unlimited flexibility with the safety and longevity of metal. With Chiksan there's never a problem of hazardous, often costly, line rupture loss. In fact, whatever fluid you are handling, you get longer life, spend less on maintenance, with Chiksan Loading Arms. Write for descriptive literature today.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

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CHIKSAN

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

Snowflakes of Caffein from Coffee Beans . . .

with DARCO®
Activated Carbon

The pure, snowy white caffein crystals that go into pharmaceutical tablets are a far cry from the near-black liquor extracted from coffee beans. It takes a major clean-up job to do this trick. A lot of color has to come out . . . and that's where DARCO® comes in. A shot of DARCO sweeps color out of the liquor, and makes possible the permanently bright, crystalline caffein.

Adsorption by DARCO is upgrading the quality of many types of products. If you'd like to improve purity or appearance by removing undesirable colors, odors or tastes, or eliminate the causes of haze or foam, there's a good chance DARCO can help.

Our line of specialized grades of DARCO gives you the best balance of adsorptive efficiency, purity, filterability and economy. We'll be glad to help you pick the right one, and give you valuable plant usage advice based on our 40 years' experience as specialists in adsorption. Just write or give us a call.

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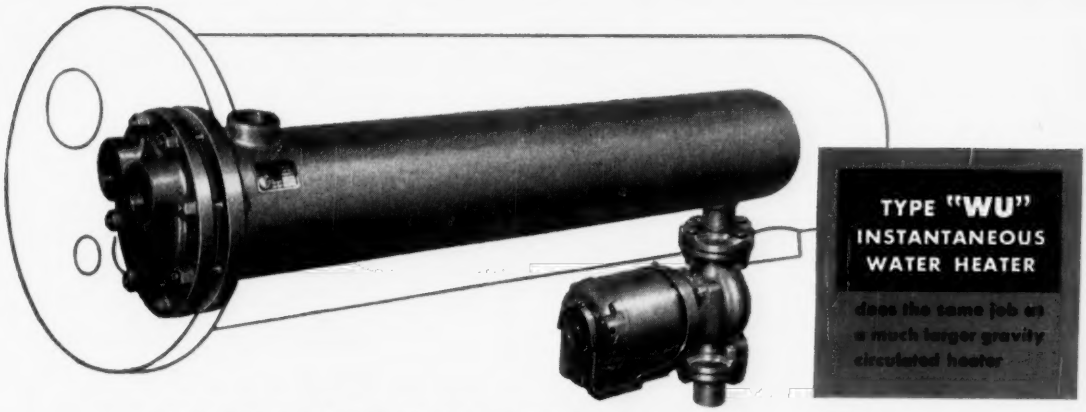


PRODUCES *MORE HOT WATER*...SAVES SPACE...SAVES MONEY

Where large volumes of hot water are continuously required, the "WU" is an economical producer

The B&G Type "WU" Heat Exchanger is an extremely versatile, instantaneous water heating unit, with a wide range of applications. It is equipped with a B&G Booster which pumps boiler water through the properly baffled shell, thereby greatly increasing the capacity of the heater. Large volumes of hot water are produced by amazingly small units.

Controls service water temperature

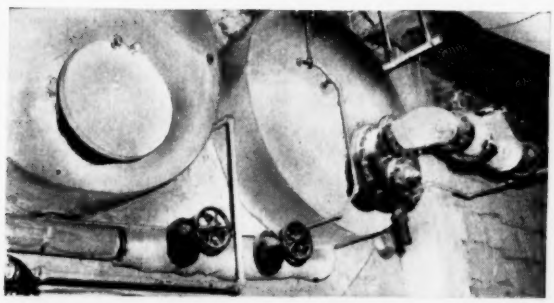
A hot water control, installed in the hot service water line, starts the Booster whenever water temperature goes below the desired degree. Boiler water is pumped through the shell of the "WU" until service water is again at the correct temperature.

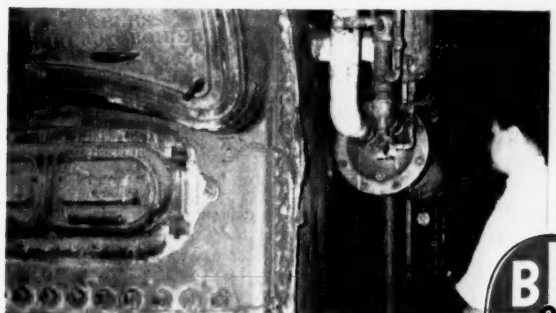
Slashes material and labor costs

Because of pumped circulation, the connecting pipes and fittings can be radically reduced in size. Material cost is trimmed to the bone and cutting and threading can be done on the job. No storage tank needed—another substantial saving.

"WU" Heat Exchangers can be installed on hot water boilers or below the water line of steam boilers.

SAVES REPLACING EXPENSIVE HOT WATER STORAGE TANKS





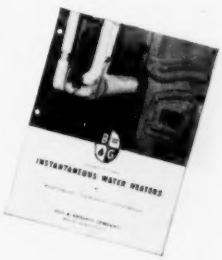
THE PROBLEM (above): How to economically replace two leaking hot water tanks.

THE SOLUTION (below): Old tanks were capped off and a compact B&G Type "WU" Instantaneous Water Heater connected to the boiler.

The photos here tell a significant story to plant managers and engineers. The "Problem" picture shows two old-fashioned hot water storage tanks, requiring replacement because of leakage...the "Solution" picture, how the tanks were replaced with a modern B&G Instantaneous "WU" Heater.

To remove and replace the two leaking hot water tanks would have been a difficult and costly job. Installing a comparatively tiny B&G Type "WU" Heater *saved hundreds of dollars* and in addition *increased the available volume of hot water!* In 12 years of operation there has never been a shortage of hot water.

Send for this booklet on the application, selection and installation of B&G Instantaneous Water Heaters.



BELL & GOSSETT
COMPANY
Dept. FH-14, Morton Grove, Illinois

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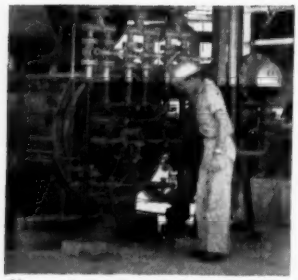
Interior of Kemp Generator in action

Burned up by inert gas costs?

Come to Kemp



Kemp Inert Gas Generator cuts inert cost 90% in Upjohn's Kalamazoo plant. Purity of gas is constant and exact qualitative analysis is maintained up to full generator capacity. Kemp generators play important roles in organic and inorganic operations throughout the country.

Kemp Inert Gas Generators end the trouble and expense of bottled gas, provide a highly flexible source of supply at a fraction of the cost. With Kemp generators in your operation, you can make liberal use of inerts . . . apply them to the improvement of many other operations. There are Kemp units to manufacture inerts in any quantity, for any application.

Kemp equipment is dependable. You get rugged design, simplicity of operation, and almost complete elimination of maintenance. Each unit is completely protected with safety devices. The heart of the generator is the famous Kemp Carburetor, for precise control of inert quality, regardless of system demands.

Kemp produced inerts belong in your plant . . . for blanketing, purging, and protective uses . . . agitation of batches during cooking . . . conveying combustibles and controlling reactions.

For new installations or modernization programs, call in your Kemp Representative. Or write us for Bulletin I-10. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

Kemp Convection Dryers

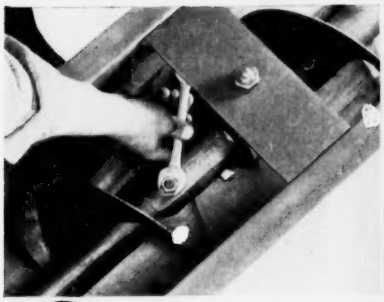
Kemp Immersion Melting Pots

KEMP OF BALTIMORE

Kemp Industrial Carburetors

Kemp Oriad Dryers

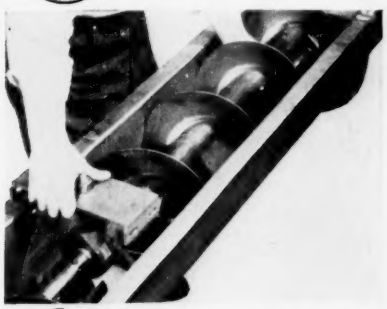
First time you've ever seen a conveyor screw changed so fast!



First, take out coupling bolts and filler piece from right-hand end of section to be removed.

Second step: take out coupling bolts and filler piece from the preceding section.

Rotate screw being removed 180 degrees so slot on preceding section is up. Then unbolt hanger.



Now simply lift the conveyor section from the trough and assemble the new one in its place.

RUNNING AGAIN. After less than 30 minutes, the conveyor is back at work.

LINK-BELT Quik-Link conveyor screw eliminates need to pull down entire conveyor line

Down-time is held to the barest minimum with the Quik-Link conveyor screw. It speeds and simplifies the maintenance man's job . . . other components need not be dismantled. And Quik-Link is just one of a whole group of new Link-Belt screw conveyor components that are cutting maintenance and power demands to a new low.

- *BALL BEARING HANGER*—has self-aligning bearing and seal, adjusts to deflection.
- *BALL AND ROLLER BEARING COUNTERSHAFT END*—connects two conveyors at right angles, permits use of a right-angle drive.
- *TROUGH END SEAL*—keeps grease in, dirt out. Used with lip, felt or waste packing seal to prevent bearing-product contact.
- *DOUBLE BALL BEARING FLANGE BLOCK*—resists overhung loads at drive end and takes thrust loads of screw.

For complete facts, call your nearest Link-Belt office or authorized stock-carrying distributor. Or write for Folder 2489.

LINK-BELT

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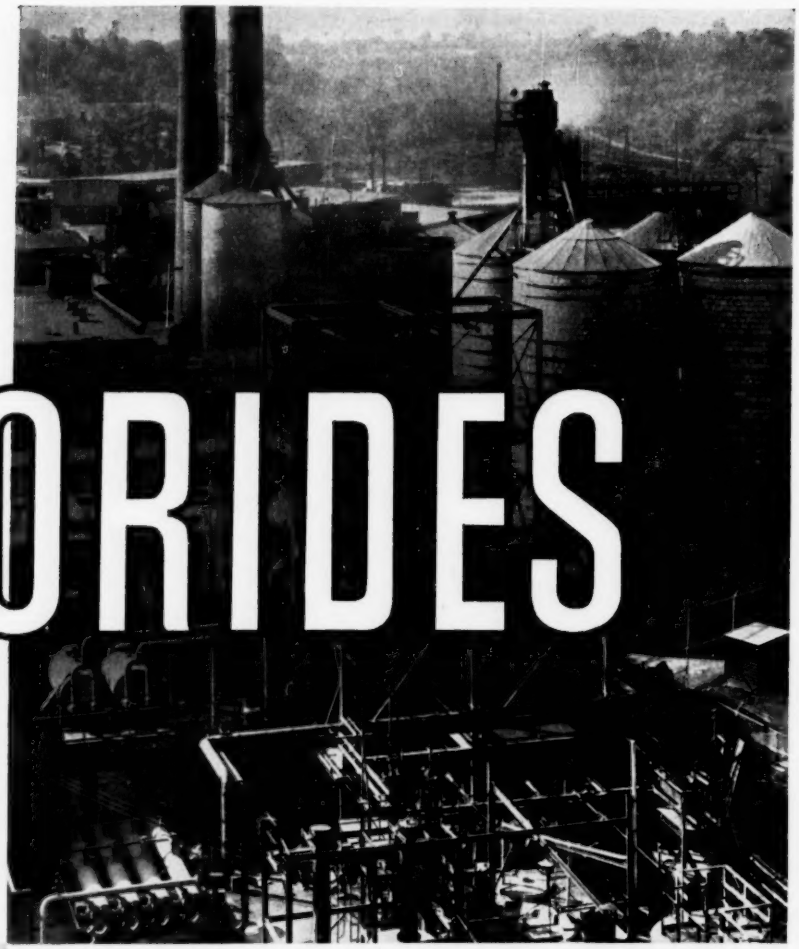

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Cadmium Fluoborate
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Metallic Fluoborates
Nickel Fluoborate
Potassium Bifluoride
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Potassium Titanium Fluoride
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HOW TO SAVE MONEY BY SPENDING IT!

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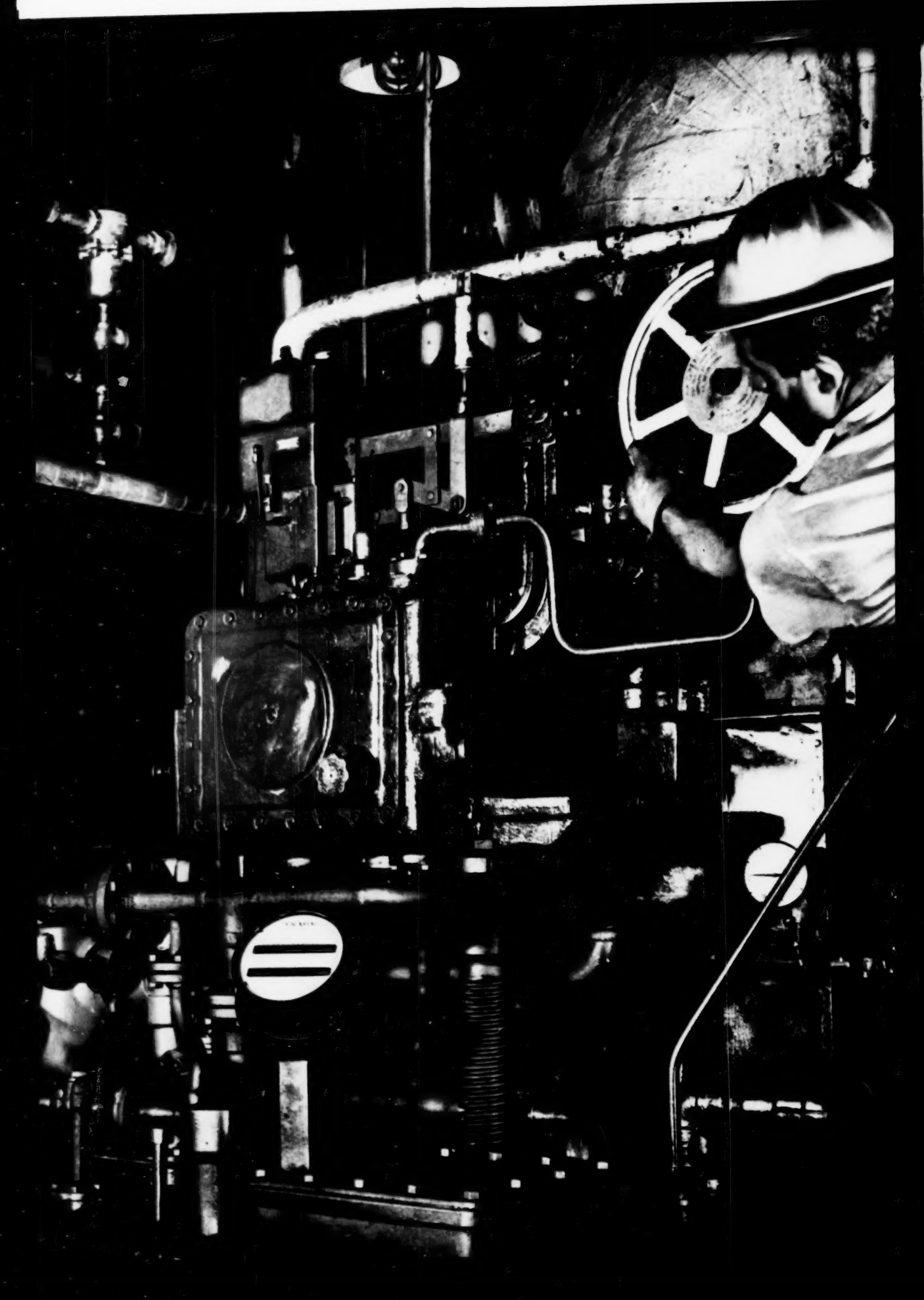
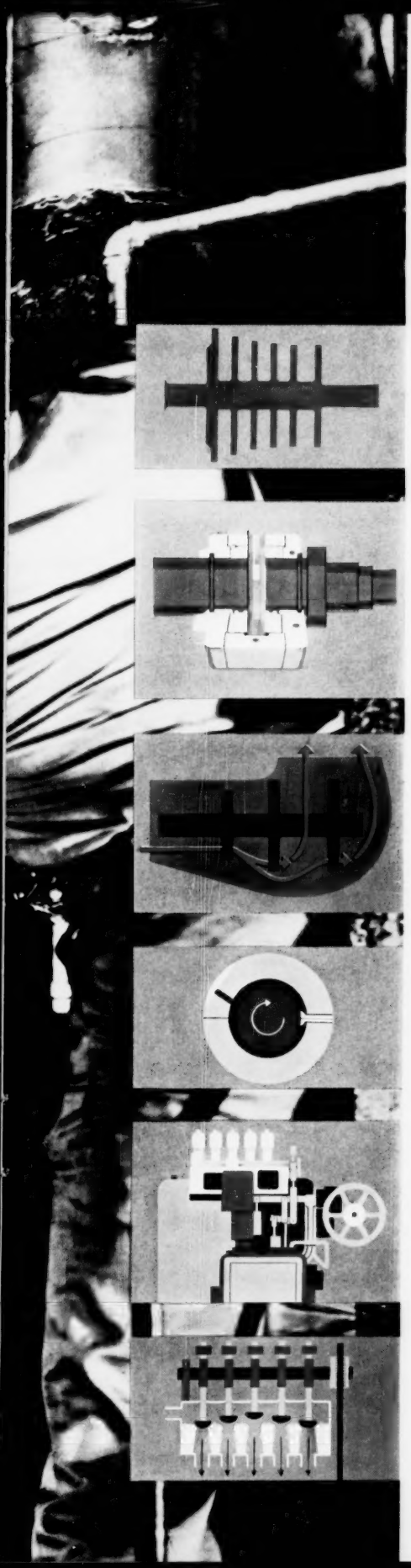
6 BASIC RELIABILITY FEATURES OF
WORTHINGTON HIGH-SPEED TURBINES
AND AVOID THE EXCESSIVE COSTS
OF DOWN-TIME LATER





Worthington High-Speed Turbines cost more to build, are used more, are worth more

(these 6 reliability facts are some of the reasons why)

Reliability Fact #1

SOLID ROTORS keep wheel stresses well within safety margins. Where needed, wheels forged integral with the shaft are used to meet the demands of modern high speeds. Solid rotor construction, a sure method of holding wheels on the shaft, provides a more rugged conservative design. Solid rotor also decreases length of turbine, thus simplifying critical speed problems and adding to efficiency.

Reliability Fact #2

KINGSBURY-TYPE THRUST BEARINGS withstand heavy thrust loads with small friction loss and low rate of wear. Bearings have babbitted surfaced multi-segment shoes that pivot on hardened buttons. This pivoting action forms a wedge-shaped oil film between the rotating thrust collar and the shoe bearing surface. This has a cushioning effect in case of unusual shock loads in either direction. The thrust load is automatically distributed equally to the several shoes thereby maintaining internal alignment as well as holding the rotor in its axial position.

Reliability Fact #3

DOUBLE-FLOW exhaust construction on Worthington turbines reduces operating stress and increases efficiency in the handling of large volumes of steam at high speeds. Steam is divided ahead of the last stage and directed through separate rows of revolving blades before leaving via a common exhaust. Double-flow exhaust construction allows reduction in last-stage wheel size and blade length, which reduces wheel and blade stress and makes possible a simplified blade design. This permits improved nozzling with consequent efficiency increase.

Reliability Fact #4

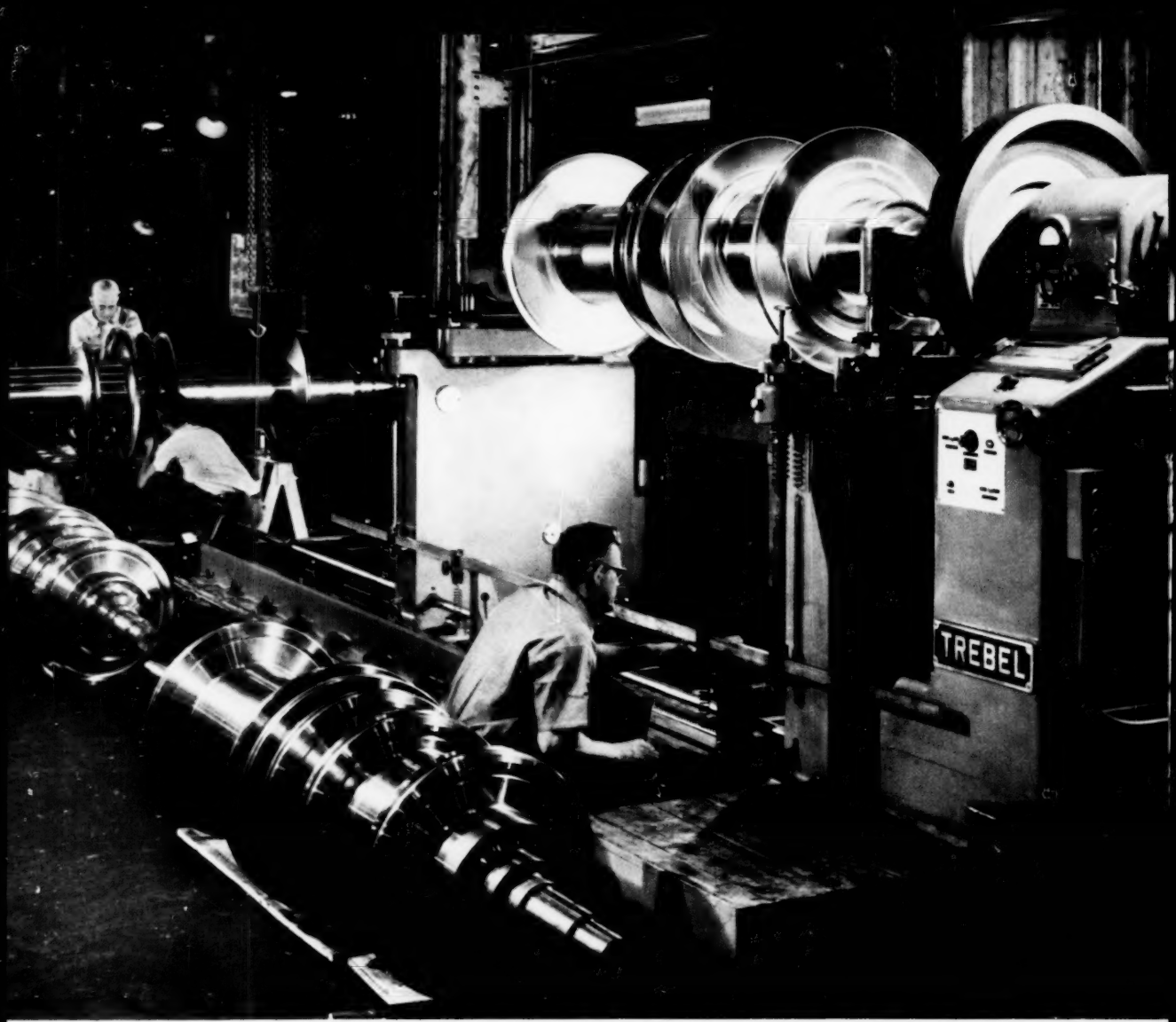
ANTI-OIL-WHIP BEARINGS are standard on Worthington high-speed turbines. A dam in the upper half of the bearing builds up a pressure pad of oil during operation. The pressure creates a downward force on the journal holding it firm in the bearing, thus keeping vibration to a minimum. Anti-oil-whip design increases life, cuts maintenance expense on bearings.

Reliability Fact #5

SENSITIVE SPEED GOVERNING SYSTEM with integral air motor combines extremely close regulation with a broad range of speed adjustment. Governor takes air impulses from an outside controller to vary speed of turbine in accordance with controller's impulse. Sensitive governor is capable of maintaining the output from the compressor substantially constant. Regardless of changes in load or steam conditions, the turbine is always under control of the speed governor, governing at any speed for which the air motor is set.

Reliability Fact #6

MULTI-VALVE AUTOMATIC NOZZLE CONTROL assures most economical operation of the turbine at all loads. Each valve automatically controls the admission of steam to a separate group of nozzles, and is operated by an independent cam mounted on a camshaft. The cams are shaped to give any desired rate of opening. The entire mechanism is mechanical, positive, and far superior to other lower-cost designs.



Balancing rotor for a 6,000 hp Worthington high-speed turbine.

THE MEANING OF LEADERSHIP

Long, trouble-free life of Worthington high-speed turbines stems from two primary sources. One: the multiple achievements of Worthington engineers. Two: the wide variety of tests to which machines are subjected before shipment to customer. Worthington, for example, is the only manufacturer that load-tests all multi-stage turbines. In this process, the turbine is coupled to a water brake so that its precise behavior under actual performance conditions can be predicted. Only when the turbine has passed this — and many other exacting tests — is it approved for shipment. This infinite attention to detail, this painstaking insistence upon perfection, explains why Worthington is today the nation's undisputed leader in high-speed turbine installations. 48-2

WORTHINGTON

WORTHINGTON CORPORATION, HARRISON, NEW JERSEY

Chemical Engineering

Developments

JUNE 16, 1958

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Chemical Economics 84

A model sodium receiving station 63

It unloads tankcars of reactive sodium headed for zirconium processing. Now, handling some 8 million lb./yr., it'll take on even more when titanium output gets rolling.

For this oxygen process—healthy claims 66

Air Products makes a strong case for its split-cycle O_2 process in terms of safety benefits, product purity and process economies. But claims provoke charges of hot air.

Phenolics take supersonic flight in a breeze 72

A new phenolic—Plaskon V-204—along with other phenolics give glass fiber laminates strengths which exceed military specs even after 100 hours of high-heat flight.

The latest in chemical process equipment 76

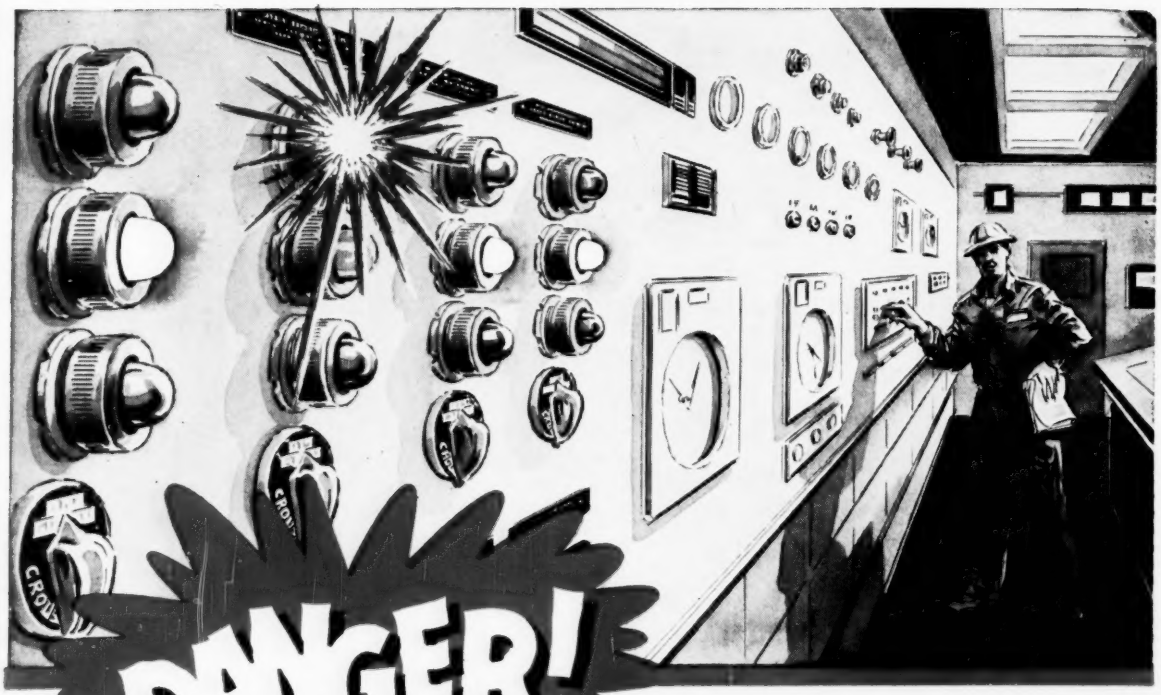
A horizontal spray dryer that assures uniform product . . . Panel-board symbols that cut manufacturing cost of control boards . . . Pail unitizer that slashes handling time . . .

For rubber chemicals: A sturdy market 84

The gains are steady and solid thanks to growth of the rubber industry, increased use of synthetics, greater need for new chemicals and broadening non-tire outlets for rubber.

Next issue: Mountaineer's new coke calcining plant

This unit turns out electrode-grade carbon from petroleum coke and will calcine green coke from Consolidation Coal's projected low-temperature coal carbonization plant.



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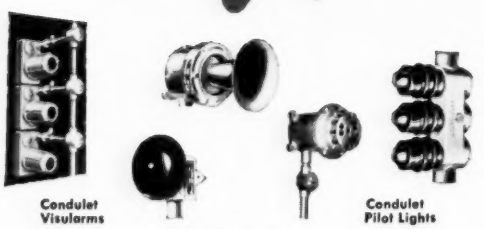

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In oil refineries, chemical plants, synthetic rubber plants — wherever constant watch of processing is necessary — Crouse-Hinds Condulet® *Visularms* provide visual indication of process conditions, and instant control of manufacturing equipment.

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A Visularm system delivers substantial savings by eliminating the necessity for buying individual components . . . housing them . . . and wiring your own system completely.

Two- or three-light styles may be mounted either vertically or horizontally. For audio warning, any number of *Visularms* may be used to operate a single horn, bell or siren.

Visularms are just one of hundreds of items in process control board equipment offered by Crouse-Hinds. Only a few are shown at left. For full information on the complete line, call your nearest Crouse-Hinds distributor, or write . . .

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DEVELOPMENTS . . .

JUNE 16, 1958

Chementator

C. H. CHILTON

Selas Corp. is working on a new type of heater for use in production of hydrogen. Details are unavailable until unit now going in is complete and running.

Desulfurization of coke-oven gas and recovery of sulfuric acid get a new look as British firm adapts fluid-bed technique to the old iron oxide process. Plant for handling 32 million cu. ft./day is now being installed by Appleby-Frodingham Steel Co.

Du Pont discloses that its chloride process for making titanium dioxide pigment yields products of distinctively high quality. Company has given products new code numbers to differentiate them from older sulfate process products.

Dual-pressure process ups nitric yield

A brand-new nitric acid process—now in commercial operation in France—utilizes two different pressure levels and a novel oxidation-absorption column to achieve product acid strengths of 69-70% and over-all yields of 97.5-97.8%.

Etablissements Kuhlmann put this new process on stream last June in a 200-ton/day plant at La Madeleine-lez-Lille. Kuhlmann has just disclosed exclusively to *CE* the basic details of the process and significant results from its first year of service.

Flowsheet-wise, the Kuhlmann process is novel in that catalytic oxidation of ammonia takes place at atmospheric pressure but absorption is effected at about 40 psi. Gases from the converter, after cooling, are boosted to absorber pressure by a centrifugal compressor. Dual-pressure operation capitalizes on the higher oxidation yield made possible by low pressure while maintaining the economy of higher-pressure absorption.

Equipment-wise, novel feature is a patented absorption column in which the trays are divided into radial absorption compartments separated by radial oxidation compartments. In this column, the NO liberated when NO_2 is absorbed in water is quickly reoxidized in liquid phase. Absorption efficiencies in the new plant have reached consistently high levels of better than 99%.

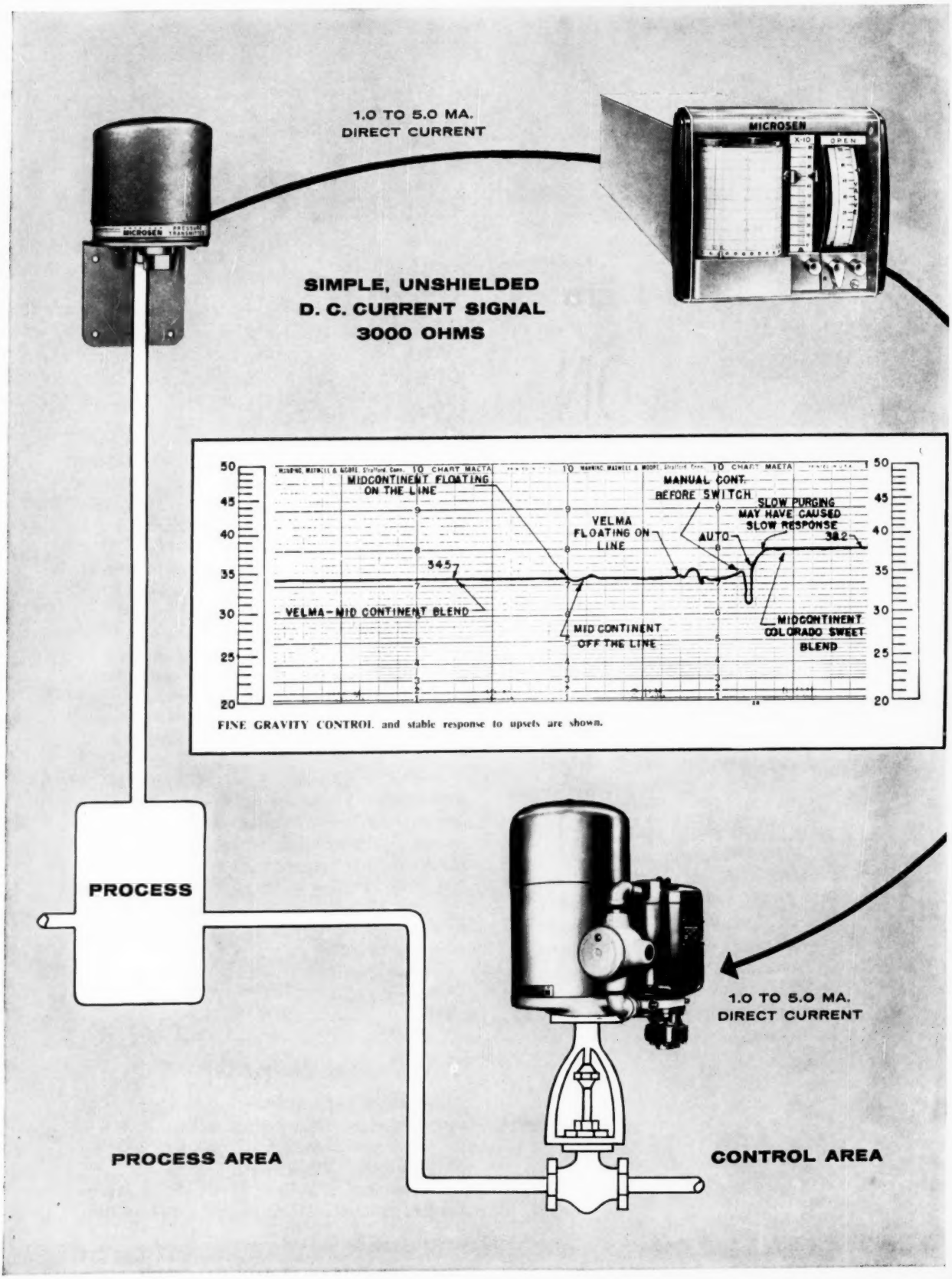
Watch for a Processes & Technology feature story on the Kuhlmann process in an early issue.

Make the alloy fit the punishment

Sharp-pencil, heads-up engineering helped save real money for Neches Butane Products Co. in its new butadiene plant due to start up next month at Port Neches, Tex.

New unit will have three steam superheaters claimed by their designer, Petro-Chem

(Continued on page 58)



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CONTROL-ABILITY

improves process efficiency and stability through electronics

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One of the best, most economical ways to step up product quality and increase quantity is to use improved instrumentation.

Some instrument systems measure and control process variables more satisfactorily than others. But the American-Microsen Process Control System performs better in numerous ways. It is completely electronic. Measurements are transmitted lag-free over long distances, without discontinuities. High accuracy and fast response give you closer control – greater process stability and efficiency.

Better measurement and control are but two advantages of the American-Microsen System. It is more economical to install and operate. It is compatible with almost all data handling or computing systems, and with process stream analyzers being developed.

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MANNING, MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION • DANBURY, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

Development Co., to be the largest units installed in the U. S. for chemical processing. Each furnace is 31½ ft. dia. by over 160 ft. high and has a heat-absorption capacity of 150 million Btu./hr.

When you're investing over a million dollars in steam superheaters alone, careful attention to selection of tube materials can pay off. A furnace with 18-8 tubes throughout, for example, will cost about four times as much as one with carbon steel tubes. Petro-Chem engineers, therefore, carefully matched materials and wall thicknesses of the 5.563-in.-O.D. tubes in various heating zones with fluid temperatures (400 F. inlet to 1,400 F. outlet) and fluid pressures (150 psig. inlet to 40 psig. outlet).

Convection section tubes are of carbon steel, 0.227-in. wall. First zone in radiant section uses 0.25-in.-wall tubes of 1¼ Cr-½ Mo, followed by a zone of 0.25-in.-wall, 2¼ Cr-1 Mo tubes. Last two zones use Type 347 18-8 stainless, with wall thickness increasing from 0.25 in. in third zone to 0.28 in. in fourth zone.

The new unit expands butadiene capacity at Port Neches from 200,000 to 300,000 tons/yr. It will be first in U. S. to use the Dow nickel phosphate catalyst instead of the conventional iron oxide-potassium oxide catalyst. The Dow catalyst has been used by Polymer Corp., Sarnia, Ont., for some ten years, and will be used also by Esso in a butadiene unit now being built at Fawley, England. Function of the superheated steam in the process is to obtain the low partial pressure necessary for dehydrogenation of butylenes to butadiene.

Bright outlook for vanadium halides

Vanadium catalysts—well-entrenched in oxidation processes such as contact sulfuric acid and phthalic anhydride—are getting the once-over for their potential in other types of chemical reactions. One promising area: polymerization reactions.

Bidding for a position in this field is Rocky Mountain Research, Denver, with an apparently new process for making vanadium chlorides. RMR is prepared to supply research quantities up to 100 lb. or more of vanadium dichloride, trichloride and tetrachloride. Already more than a score of firms interested in these materials have contacted RMR.

RMR's process involves the direct chlorination of vanadium pentoxide to VCl_3, bypassing the vanadium carbide or sulfide intermediates of classical processes. Details of this step are unavailable pending issuance of patents. Vanadium Corp. of America supplies V_2O_5 starting material from its Durango, Colo., plant.

Trichloride is thermally disproportionated to dichloride plus tetrachloride at atmospheric pressure and 300-400 C. Key to successful operation here is to sweep the reaction with CO_2 in order to remove the VCl_4 rapidly and prevent undesirable side reactions from occuring.

Bakelite's recent disclosure of a new catalyst system for making linear polyethylene gives E. F. Vandersarl, RMR's president, a bullish outlook on the future for vanadium halide catalysts. Vanadium bromide is a key ingredient in Bakelite's catalyst system, which also includes tetraphenyl tin and aluminum bromide.

A Bakelite spokesman says that vanadium bromide was picked because of its stability and availability, that the chloride would probably be cheaper if the new process went commercial. Vandersarl visualizes an eventual price structure for the chlorides in the range of $3-4/lb.

Induction heat speeds pipeline welding

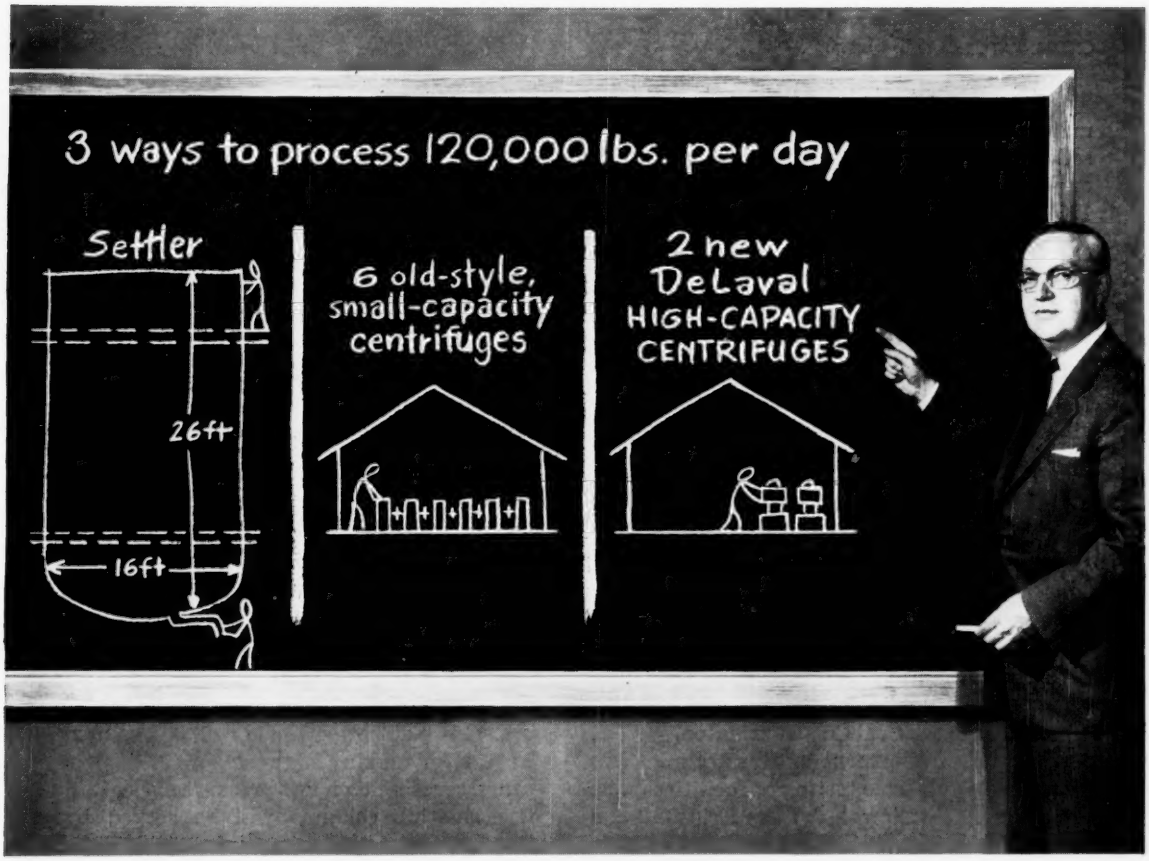
Butt-welding of steel pipe in the field can be done in as little as 1½ min. with a newly developed 10,000-cycle induction heating system. Consolidated Edison Co. has produced several hundred welds in the past few months while laying pipe in congested New York city streets.

Equipment was developed by New Rochelle (N. Y.) Tool Co., a firm specializing in high-frequency industrial machines. Current is provided by a diesel-driven, 100-kw., single-phase generator. Con Edison's mobile unit can handle pipe up to 14 in. dia., but the New Rochelle company is designing welders for pipe of even larger sizes.

Soil freezing scores twice more

Potash Co. of America will lead off the batting order when Saskatchewan's new potash industry, now numbering 14 firms, gets under way this year. The company expects to reach the 3,000-ft. pay-zone level this month in its shaft-sinking operations.

(Continued on page 60)



Blackboard sketches show relative space required by settler versus small centrifuges versus new high-capacity centrifuges

"High-capacity centrifuges offer important savings in manpower and floor space"

Fred Wheelwright, De Laval Separator Co.

WITH floor space costing what it does today, we wonder if processors realize just how expensive settling tanks really are. The blackboard sketch above gives you a rough idea of how much floor space (and cubic space too) you can save with centrifuges . . . especially De Laval's newest high-capacity machines.

As you can see, two high-capacity centrifuges equals the capacity of six old style machines equals one enormous settling tank. In addition, the centrifuges turn batching into continuous processing, create higher yields of more uniform quality . . . at far lower labor costs.

To give a typical example:
A southern vegetable oil refiner had a large four-story plant containing settling tanks. When they changed over to the centrifuge method, they knocked out the floors of one bay . . . built a small two-story brick refinery inside the old shell. Later they knocked off the old walls and roof, let the new plant stand outdoors. Then they turned the settling tanks into storage facilities. Their new refinery takes less than a third the space of their old plant and needs only half the manpower for the same production. And, yields and quality are far higher.

De Laval can give you many similar cases where high-capacity centrifuges save space and manpower, improve yield and quality. If you'd care to send us the design criteria for your product or process data on your separation problems, our Engineering Department will give it a careful analysis and submit their objective recommendations. All in strict confidence, naturally. And our complete pilot plant facilities are at your disposal.

If you'd like a four-page brochure of specifications on the De Laval line of centrifuges for the process industries, just write on your letterhead.

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PCA ran into early difficulties with soft material. These were overcome by using the soil-freezing technique which the company had employed successfully at Carlsbad, N. M., in 1951, and which has subsequently been applied to salt mining (*Chem. Eng.*, May 1957, p. 158). PCA has scheduled a total investment in the new project of $20 million.

International Minerals & Chemical is expected to be second in operation in the new field when it completes its $18-million project. IMC, too, has had to resort to soil freezing in sinking its shaft.

Latest arrival on the potash scene is a West German firm, Winsal of Canada.

Steam generator doubles as coke oven

Production of coke on a souped-up traveling-grate stoker while generating steam with the liberated heat may be the way to get around today's high investment and operating costs of byproduct coke ovens.

Island Creek Coal Co., Huntington, W. Va., has carried development of this technique to the point of full-scale testing in facilities made available by Pittsburgh & Lake Erie Railroad at McKees Rocks, Pa. Three carloads of coke product were shipped last month to American Cyanamid at Niagara Falls, Ont., for evaluation as calcium carbide feedstock.

Idea behind this process is that by running the stoker twice as fast as normal and by controlling air admission, the volatile matter in the coal is burned to provide heat for coking and to raise steam, while most of the fixed carbon in the coal is recovered in the form of small-sized, porous, high-temperature coke.

Basic idea itself is not new. Shawinigan Chemicals Ltd. in Canada and Rand Carbide in South Africa produce coke for calcium carbide manufacture by this method, with combustion heat going to their lime kilns. But Island Creek would like to divorce the process from calcium carbide manufacture. Generation of steam and power offers a more flexible setup while providing the economic credits needed for low-cost coke.

Silica gel: Death to la cucaracha

New approach to control of cockroaches is to dry 'em to death with silica aerogel.

Recent experiments at Univ. of California (Los Angeles) showed "startling" results when Davison Chemical's Syloid was sprinkled on the floor of cages. The inert, nontoxic dust achieved 100% kills in shorter times than currently used insecticides which, incidentally, were not always 100% effective. Theory is that the silica gel powder adsorbs an oily protective film that covers the entire body and normally prevents loss of water. Thus the powder causes death through desiccation.

Significance of this discovery lies in the fact that roaches, as well as other type of insects, have been showing increasing resistance to common insecticides in recent years. Because the silica powder has no chemical action, roaches will probably not be able to develop resistance to it.

Coming: Tonnage oxygen via pipeline

Tonnage oxygen outlook takes a sharp upturn with Linde's announcement that it will build a 1,000-ton/day plant at Duquesne, Pa., to serve four mills of U. S. Steel Corp. along the Monongahela River near Pittsburgh.

This plant, says Linde, will be the world's largest for making high-purity (99.5%) oxygen. Operating on a low-pressure cycle, its two fractionating columns will be served by a single, giant compressor drawing 22,500 hp. Product will be piped at 250 psi. to the four steel mills via a distribution system consisting of 7½ miles of pipe ranging from 12 to 20 in. dia. Pipeline will make two river crossings on existing bridges.

Linde will own and operate the new plant, maintaining in operation also the $3-million, 500-ton/day dual-purity plant installed at Duquesne only a year ago (*Chem. Eng.*, Sept. 1957, pp. 152-4). Three small units now located at the other three steel mills, totaling 160 tons/day capacity, will be removed.

Thus the steel industry sets the pace in today's growth of tonnage oxygen (see pp. 66-68 in this issue for story of Jones & Laughlin's new oxygen unit). Use of oxygen in steelmaking has climbed from about 30 cu. ft./ingot ton in 1930 to the present national average of 200 cu. ft./ton. About half this is used for scarfing, cutting, scrap preparation, etc. The portion used for metallurgical operations, however, is expected to grow more rapidly as the industry turns to greater use of oxygen in blast furnaces, open-hearth furnaces and the new oxygen converters as a way of boosting iron and steel capacity at minimum cost.

For more on DEVELOPMENTS.....62

HOW BOWSER Liquid Handling SYSTEMS CUT COSTS

WITH AUTOMATIC CONTROL AND GREATER ACCURACY

Automate your metering, batching or blending operation with a Bowser liquid control SYSTEM . . . and get these BENEFITS . . . lower initial investment . . . completely automatic control . . . unsurpassed accuracy . . . increased efficiency . . . single source of supply . . . and system performance guaranteed by Bowser, Inc.

Rate of Flow Controlling System

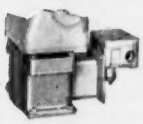
The Figure 417 Rate of Flow Controller is a completely self-contained system enabling fully automatic and accurate CONTROL of the rate of liquid in flow . . . to better than ¼ of 1% accuracy. Handles flow rates from ½ G.P.M. to 250 G.P.M.

Liquid Blending System

The Figure 413 Precision Blending System automatically and accurately blends two or more liquids in closed, continuous production. Accuracy within ¼ of 1% and completely automatic operation . . . assures uniform blend . . . reduces blending costs by 50%.

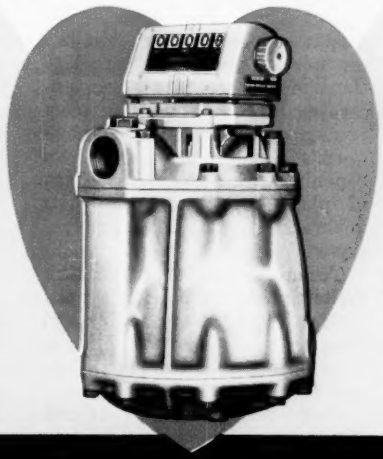
BOWSER METERS AND ACCESSORIES . . . offer complete systems for every type of liquid control requirement

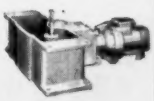
MODEL L . . . straight-reading dial records liquid metered up to 100,000 gallons.



IMPULSE TRANSMITTER . . . transmits electrical impulses to a remote counter which records quantities, controls automatic batching.

MODEL K . . . Printing Dial provides printed records of quantities metered for inventory control, etc.





MODEL F . . . relays voltage signal to a remote flow indicator or controller permitting remote observation and control of the flow rate.

MODEL RP . . . automatically delivers repeated predetermined quantities of liquids.

REMOTE PREDETERMINING COUNTER . . . records electrical impulses from meter permitting automatic delivery and shutoff control for predetermined quantities.

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Clues Gathered in Carbide Explosion

Probable cause of the explosion at Union Carbide's Texas City, Tex., oxygen plant was ignition of combustible waste material in a covered trench under floor of plant building. That's the conclusion reached by investigators after careful sifting of all evidence.

It was quite clear that explosion did not occur in any of the production equipment since the only damage suffered was from flying debris. As story is pieced together, operators were draining liquid oxygen from one of two columns preparatory to thawing for routine maintenance. A leak somewhere in the oxygen drain line in trench apparently caused an oxygen buildup leading to explosion.

In rebuilding the plant, Carbide emphasizes, this trench will be eliminated.

Alloys From Oxides: New Process Promise

One major factor holding up wider industrial application of the newer "wonder metals" of the nuclear age is their relatively high pricetag. Now a Canadian firm, Alscope Explorations, Ltd., is developing a process that can produce alloys of such metals as titanium, zirconium, molybdenum and vanadium at a quarter of their present cost.

This big cost reduction stems from raw material economies—process uses commercial-grade oxides of these expensive metals and alloys them directly with base metals. (At present, these oxides cost only about one-tenth as much as the corresponding metal.) Process is now in pilot-plant stage.

Heart of this continuous scheme is an induction furnace operating at 2,000-2,500 F. Oxide powders are added directly to melt in furnace along with alloying base metals such as aluminum, magnesium or copper. One of the base metals naturally must be a reducing metal. Reduction of the oxides to metallic state takes place under a argon or helium atmosphere. Wide range of alloys can be made by varying oxide and base metal ratio.

Two streams, slag and molten eutectic, are drawn continuously from furnace. Holdup time in the 5 to 10-lb.-capacity pilot furnace is a few hours. Alscope feels that process has proved itself a technical success and is economically sound; it now hopes to license process to metal producers. Several firms have expressed interest, but none is committing itself right now.

Slush Molding Slated For Polyethylene Use

Slush molding, a technique usually associated with vinyl plastisols, has now been adapted for use in commercial applications of polyethylene. And, according to J. R. Davidson, sales manager for Allied Chemical Corp.'s Semet-Solvay Div., it's "opening up a whole new concept of plastics manufacture." It's generating a good deal of industry-wide interest.

Technique consists of pouring molten polyethylene into a split mold, allowing it to solidify and then pouring off excess. Mold is then opened and the plastic object removed.

Best results are obtained, Davidson explains, by using a blend of high and low molecular weight polyethylene so that material will flow readily and still have good strength properties. Viscosities of 5,000 to 10,000 centipoises at 300 F. have proved best.

Allied has found that the weight of the molded object is a function of viscosity, setting time, temperature and molding conditions. As a rule, use of high temperatures and lower-viscosity formulations give the lowest weights.

Zinc in Foil Form Is Pilot-Scale Reality

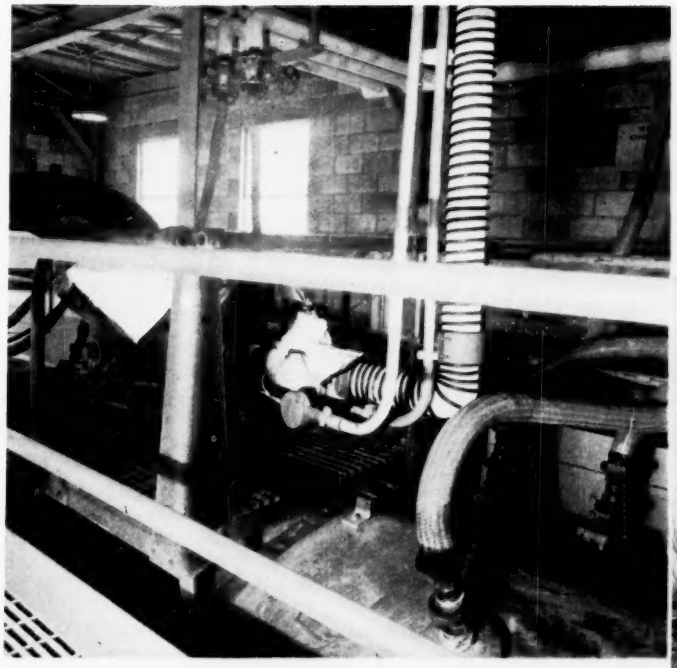
Technical reality but still an economic oddity—that's the present status of process American Smelting & Refining Co. has developed for producing zinc foil. Asarco has a pilot unit turning out development quantities of the foil at its South Plainfield, N. J., laboratories. But no commercial outlets have yet developed.

Zinc foil is produced by electrowinning, similar to technique used for making copper foil (aluminum foil, by contrast, is rolled from metal billets). Asarco's unit consists essentially of an aluminum-drum cathode rotating in a zinc electrolyte bath; stationary lead anode in bath, 1 in. from drum, follows contour of the aluminum cathode. As zinc plates out on drum, it is continuously stripped off, rinsed, and rolled up on a collecting reel.

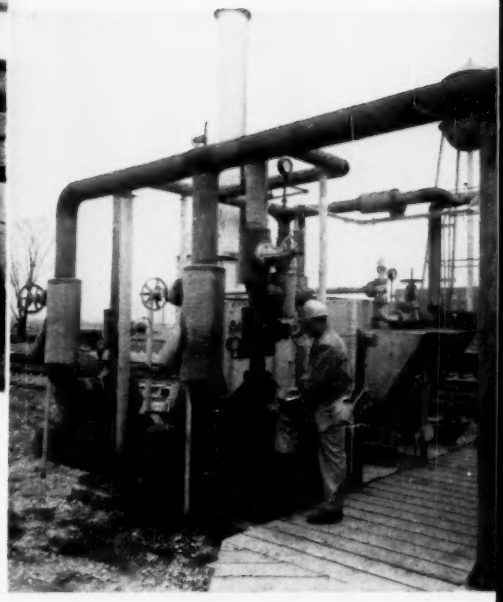
Secret of the process is in being able to strip foil cleanly away from drum. This is mainly a function of the aluminum surface—it must be clean and free from pitting. Current efficiency in foil unit is around 90%, about the same as conventional zinc electrowinning cells. So on a pound-for-pound basis, zinc foil should be even a little cheaper than ingot zinc because foil doesn't require the additional remelting and casting steps.

▶ **Thick and Thin**—By varying drum speed and current density, Asarco's unit makes zinc foil ranging from 0.001-0.006 in. in sheets up to 26 in. wide. Product is uniform, varying no more than 0.0001 in.

Since pilot unit has been operating on zinc electrolyte from Asarco's Corpus Christi, Tex., refinery, it would be a relatively simple matter to scale present unit up for installation in the electrolyte circulation system at Corpus Christi. All that's needed now is a market—best prospect to date seems to be as a vapor barrier in building paper.



MOLTEN sodium discharges from tank car through vertical pipe heated by induction coil. Hot oil flows into tank car coils through metal hoses.



GAS-FIRED heater raises temperature of heating oil. Then, pumps circulate oil to car to melt sodium.

Bulk Station Shows-Off Easy Sodium Handling

Incorporating latest know-how, new facility unloads tank cars of sodium as easily and safely as most plants unload other types of bulk chemicals.

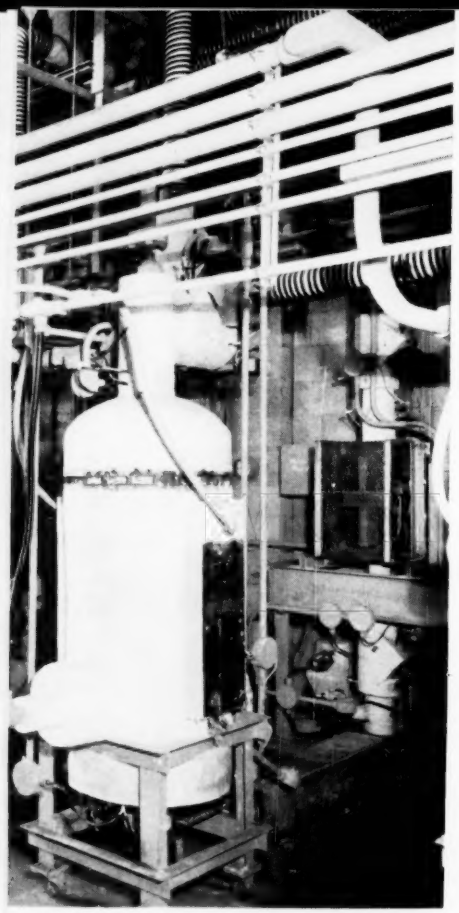
At its new zirconium and titanium plant now on stream at Ashtabula, Ohio, Mallory-Sharon Metals Corp. unloads tank cars of sodium through a receiving station that's a showplace on "how to handle bulk sodium." But more important, it assures safe delivery of up to 2-million lb./yr. of sodium for producing zirconium, soon will handle 10 times as much when titanium production gets rolling.

Interleaved into the design of this receiving station is much knowhow developed by U. S. Industrial Chemicals, Inc.,* to smooth sodium's way to point of use. And, U. S. I. feels that the installation demonstrates conclusively how users can handle sodium as easily as other bulk chemicals.

* Sodium-maker U. S. Industrial Chemicals, Inc., is one-third owner of Mallory-Sharon Metals Corp.

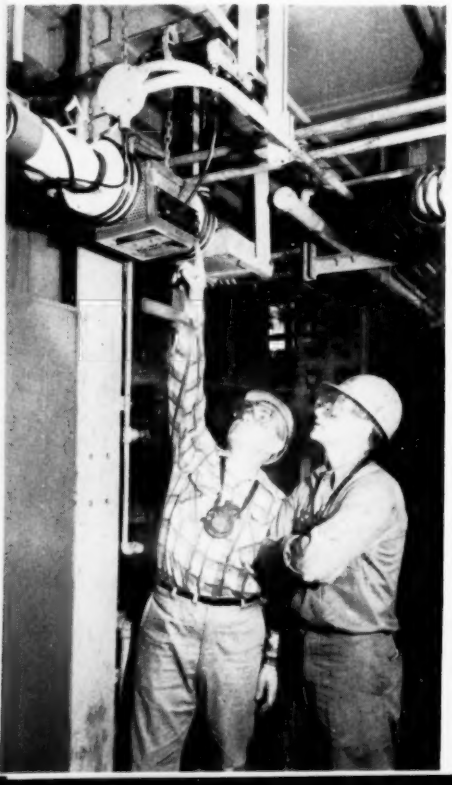
People now using tank car quantities of sodium to produce titanium, zirconium, tetraethyl lead, sodium peroxide, sodium cyanide, fatty alcohols and sodium hydrides handle it with that degree of facility. U. S. I. hopes others will accept this outlook and capitalize on sodium's chemical properties.

▶ **Action Under Wraps**—Sodium comes to Mallory-Sharon in 80,000-lb. chunks, enclosed in tank cars under argon blankets. With the facilities at the receiving station, Mallory-Sharon melts the 80,000-lb. mass, transfers it to storage and then to process



FILTER (above) removes sodium and calcium oxides. Electromagnetic pump is behind grill.

FLOWMETER in sodium line works by same principle as the electromagnetic sodium pump.



without contamination of the molten metal or hazard to personnel.

Receiving station is set up so that tank car, on arrival, becomes a link in an enclosed system that transfers the sodium into the plant system free from contact with any contaminating materials which react readily with sodium.

To melt the sodium, Mallory-Sharon circulates hot oil through coils in the tank car. Then, electromagnetic pumps transfer the molten metal through lines, valves and filters that are heated electrically. Complete instrumentation assures control at all times.

▶ **Tie Car to System**—Switcher spots loaded car at one of two unloading positions at the Mallory-Sharon receiving station. Operator connects flexible, insulated, metal oil hoses to fittings on each of six heating coils in car and connects sodium line to sodium eductor valve on top of car.

Heat-transfer oil (Schivis J-53) from 5,000-gal. surge tank is pumped through a 2-million Btu./hr. gas-fired heater which raises oil temperature to 270 F. From the heater, centrifugal pump moves 170 gpm. of oil to car heating coils. Circulation of the hot oil at this rate for 8-12 hr. melts the sodium (m.p. 208 F.) and heats it to 250 F.

▶ **From Car to Filter**—Then, car is pressurized with argon gas to force the molten sodium up the eductor pipe to two preheated electromagnetic pumps. Actuation of primed pumps through 0-440-v. powerstat voltage control starts sodium flowing continuously via heated pipes to three 14-sq. ft. tank filters containing porous, cylindrical, stainless-steel filter elements having a 20-micron pore size.

▶ **Filter to Storage to Process**—Freed of suspended sodium and calcium oxides, the molten sodium is piped to the 156,000-lb. storage tank. This tank is heated by a 35-gpm. side stream from the gas-fired heater in order to hold the sodium at 250 F. Argon at 8 psi. is maintained over the sodium at all times and is replenished as the tank liquid level drops.

Withdrawals from storage pass through another bank of filters before passing on to process.

When tank car is empty, sodium lines are disconnected and the car pressurized with argon to 10 psi. Following blowdown of oil from the heating coils back to the surge tank and disconnection of oil lines, car is ready for return to sodium plant.

▶ **Lines and Valves** — Sodium lines are Schedule 80, 2-in. seamless carbon steel with welded connections, except for flanged connections at valves and vessel nozzles. Around lines are wound the induction heating coils, 12-14 turns/ft.

This simple installation is easy to maintain and heats the pipe cross section rapidly and uniformly. Nearly 1 mi. of pipe is heated this way.

Valves are bellows-sealed "Y" globe type with raised face flanges and blue asbestos gasketing. These and the tees and nozzles are kept hot by electric-resistance heaters, because induction heaters are impractical on such shapes. Similar heaters also keep pumps and filters hot. Suitable insulation cuts heat loss.

▶ **Close Control** — Flow of hot oil to the car is controlled by an orifice in the line, connected to a meter. Any drop in oil temperature will raise viscosity and cut flow through the orifice, indicating it on the meter.

Temperature of oil is measured at six different points on the circulation loop. The reading at the heater outlet controls the flame in the heater.

On the sodium side of the system, both the electromagnetic pumps and the filters are connected to temperature indicator-controllers. Pump heaters are set up to shut off automatically when pumps start, since pumps generate heat during operation.

Quantity of sodium pumped is controlled manually by the powerstat transformers and indicated by electromagnetic flowmeters.

A 12-position alarm system protects against overloads or failures on sodium tank level, argon pressures, heater flame and pumps.

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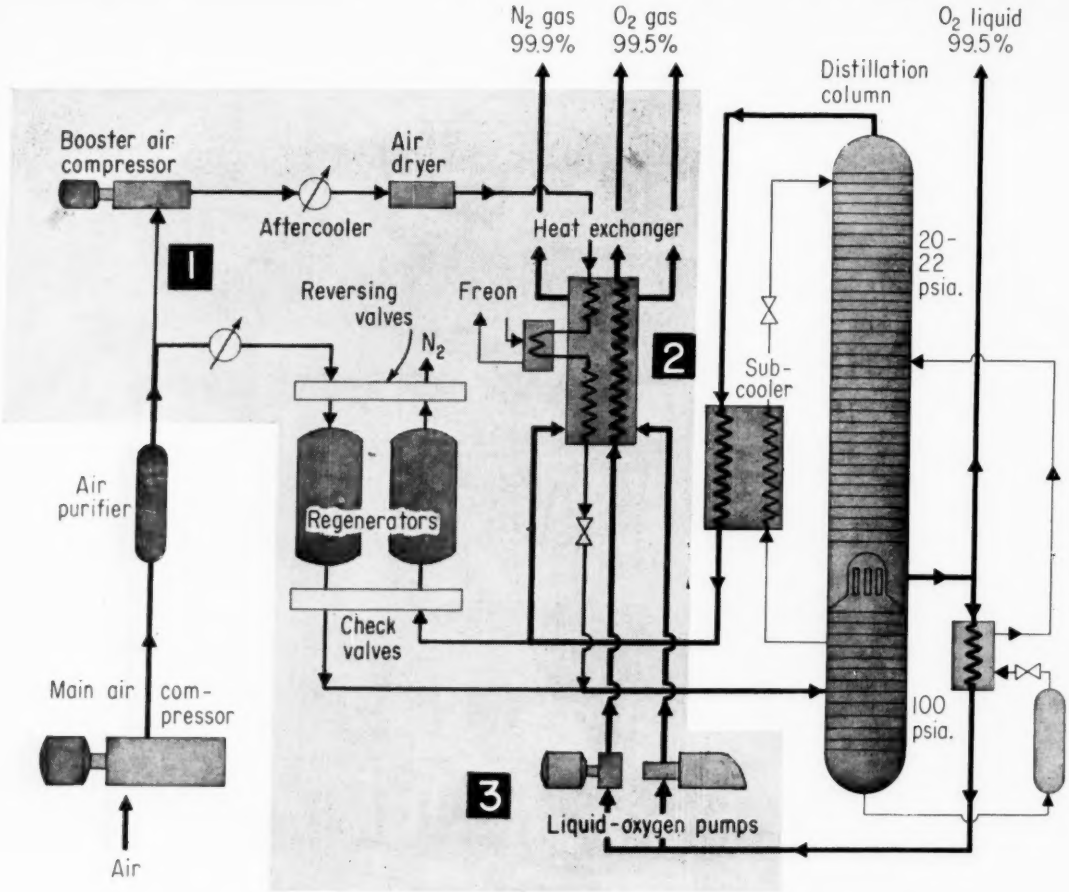


1. AIR STREAM splits, smaller flow gets more refrigeration via booster compressor
2. HEAT EXCHANGER cools air with three product streams plus critical Freon cooler
3. LIQUID-OXYGEN PUMPS deliver oxygen at 450 psig., handle liquid rather than gas

Split Cycle Claims Less Energy

Cycle	Energy (kwh./ton O_2)	Product Purity (percent O_2)
Low-pressure	464	95-98
Medium-pressure	564	99.5
High-pressure	858	99.5
Split	**487**	**99.5**

New Oxygen Route Vies for On-Site Honors

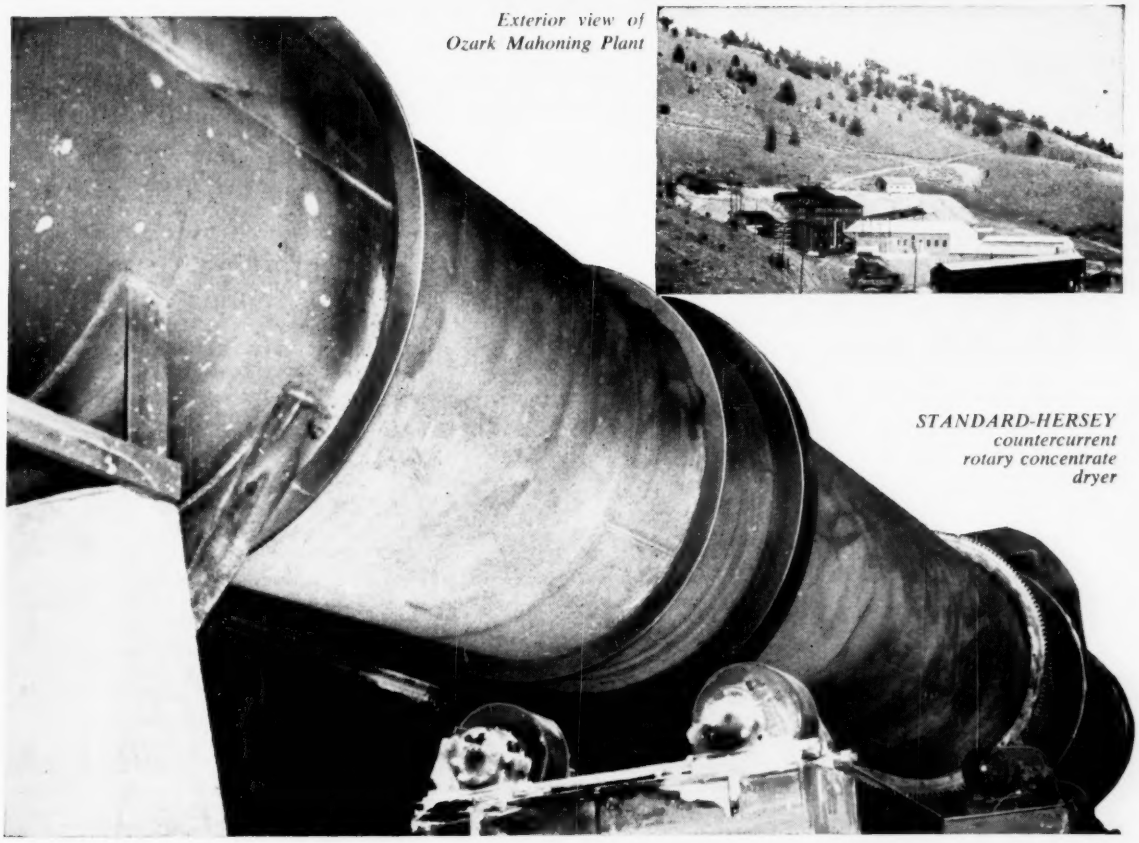
In a field as hotly competitive as the one in which oxygen makers find themselves, a new oxygen process can be expected to attract a lot of scrutiny.

And that's just what's happening with Air Products Inc.'s new split-cycle, air-fractionation process for on-site oxygen making. The first such installation has now proved successful during its six months' on-stream time for Jones & Laughlin Steel Corp.'s Aliquippa, Pa., works.

Other oxygen makers, however, register dissent with Air Products' basic premise—making liquid oxygen on site—and on a number of points in process design.

Nevertheless, customers' reaction to the new route, Air Products notes, has been highly favorable. In addition to the two 115-ton/day units built for J&L, Air Products has contracted for three more installations, including a 60-million-cu. ft./mo. unit starting up for Granite City Steel Co., Granite City, Ill.

► **Fuses Two Routes**—Key feature of the new route (see flowsheet above) is the tie-in of two



Exterior view of Ozark Mahoning Plant

STANDARD-HERSEY countercurrent rotary concentrate dryer

FLUORSPAR CONCENTRATE DRIED TO ALMOST 0% MOISTURE BY A

STANDARD HERSEY ROTARY DRYER

The Northgate, Colorado plant of Ozark Mahoning Co. produces Acid Grade Fluorspar exclusively. Since their flotation concentrator went into production in October of 1952, output has increased to the point where their Standard-Hersey dryer *is now operating at 150% rated capacity.*

The filter cake, produced in Denver equipment, is transported by screw conveyer to a stacking belt for stock piling and sampling, or directly into the 6′ by 50′ Standard-Hersey countercurrent rotary dryer. Moisture in the concentrate is reduced by the dryer from 12-14% to approximately 0% for shipment.

The dryer is lined throughout its length with refractories, as is the dryer furnace. Exhaust gasses at 350°F. pass through a cyclone type dry dust collection system with a balanced airlock arrangement. The temperature of the discharge product is 450°F. Semi-automatic burner controls provide efficient operation of the dryer unit.

The unusually large diameter of the dryer was selected to minimize the velocity of the gas stream through the dryer thus reducing concentrate dust loss to an estimated 1-ton of concentrate per 24 hours.

The engineering staff of the 52 year old Standard Steel Corporation has thousands of successful dryer applications to draw on in solving your problems. Over 30 types of dryers are available to fill almost every drying need in the chemical and food fields.

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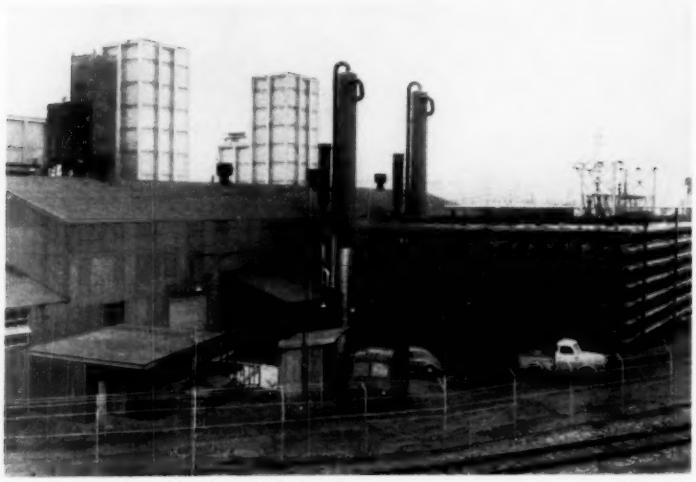
Midwest Offices & Plant **LEADER IRON WORKS** *Decatur 5, Illinois*

(Division of Standard Steel Corporation)

ROTARY DRYERS • KILNS • COOLERS • ASPHALT PLANTS



SURGE CYLINDER STORAGE holds oxygen gas at 450 psig. for use.

well known oxygen processes—the low-pressure and high-pressure cycles. Hence the name, split cycle.

For conditions such as those at Aliquippa and other steelmaking sites, says Air Products, the split cycle represents a technical breakthrough for giving a reliable supply of high-purity products at low power consumption.

Critically important to low-power, split-cycle performance, Air Products points out, are these process-design points: Weight ratio of low-pressure to high-pressure streams (roughly three to one), temperature conditions on the auxiliary heat exchanger and the use of liquid oxygen pumps as a means of elevating gaseous pressure on the product-oxygen stream.

▶ **Combines Merits** — The split cycle, Air Products claims, combines merits common to the conventional high- and low-pressure cycles—liquid oxygen capability; safe, reliable production of pressurized gas; and low power consumption. Normally, the low-power, low-pressure cycle doesn't produce liquid oxygen, requires fully-spared gaseous oxygen compressors and complex safety devices for equal reliability.

Low power consumption of the low-pressure cycle is due chiefly to efficient operation of rock-filled regenerators acting as heat exchangers. Huge surface area allows very small ΔT (about 5 deg. F.) at the warm end. To this cycle, Air Products weds liquid-making potential of the high-pressure cycle.

▶ **How Process Works** — Air is compressed to about 103 psia. in the main air compressor and then split into two streams, about 25% of it going through booster compressor (to 1,500 psig.) and auxiliary heat exchanger.

Low-pressure stream goes through regenerator packed with quartz rock (while swing regenerator is cooled and cleaned by effluent nitrogen) depositing water vapor and CO_2 impurities. Regenerator cools this stream to near liquefaction temperature. High-pressure stream, after Joule-Thomson expansion, joins the low pressure stream and together they enter the distillation column at about −270 F.

High-pressure (100 psia.) section of column splits off nitrogen (reflux for upper section) and crude oxygen (35% O_2) which is sent to low-pressure (20-22 psia.) section. This section gives liquid oxygen (99.5%) at −292 F. and nitrogen (99.9%) at −314 F.

▶ **Freon Keys Exchanger** — Freon introduced into the auxiliary heat exchanger at about −40 F. does a critically important job in opening up the cooling curve so that it can operate at a small ΔT, and thus at higher efficiency.

Without Freon cooling help, Air Products would have to put in a lot more heat-exchange surface or more refrigeration power where it wouldn't count as heavily.

▶ **Uses Oxygen Pumps**—In preference to other possibilities, Air Products uses liquid-oxygen pumps to pressurize part of the liquid product from the low-pressure column. (450 psig. via centrifugal pump for surge cylinder storage and 2,400 psig. via reciprocating pump for a small amount of portable cylinder storage).

In this way, auxiliary heat exchanger recovers refrigeration by evaporation of pressurized liquid oxygen, and the gas is at proper pressure for storage. Storage at 450 psig., Air Products explains, is a matter of overall plant economics and is the reason for pumping liquid oxygen to this pressure (rather than to 150 psig. load pressure) from slightly above atmospheric.

Advantages of pumps over oxygen compressors, Air Products maintains, are strikingly lower first cost, power consumption and maintenance. Too, pumps serve to drain oxygen product from the intercolumn condenser-reboiler and draw off dangerous accumulations of hydrocarbons.

▶ **Opinions Conflict** — Differing viewpoints among oxygen makers include one major one which has repercussions throughout the process setup: To make liquid oxygen on site or to haul it in from off site.

Linde Co., for example, strongly maintains that, in installations up to 20-25 million cu. ft./mo., it's cheaper, both for customers and for Linde, to haul liquid oxygen from one main plant to a number of customers.

Too, the value of liquid made on site is limited by storage economics, while hauling it in gives more flexibility to the operation.

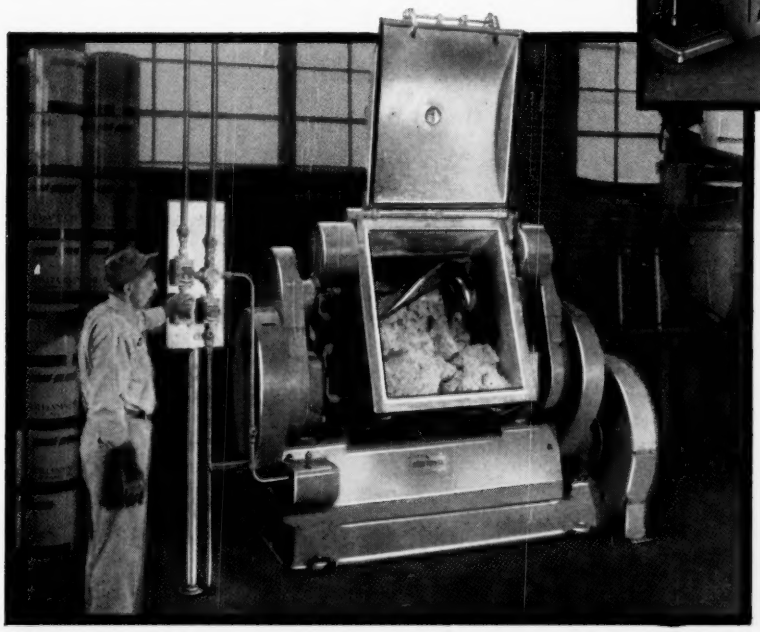
Air Products, equally strongly, maintains that the reliability and safety of its on-site plants still offer better advantages.

▶ **Other Differences** — Another oxygen maker takes a critical view of using oxygen pumps.

BAKER PERKINS MIXERS duplicate laboratory results on a production scale at WILLIAMSON ADHESIVES, INC.

Williamson Adhesives, Inc., of Skokie, Ill., are engaged in custom compounding of a wide variety of pre-mix molding materials for sale to the compression molding industry. To insure duplication of pilot results, Williamson uses Baker Perkins Mixers in both laboratory and production operations. A small 2.25 gallon Baker Perkins batch mixer is used in the laboratory for making test runs and developing new products, while a 100 gallon B-P mixer is used for actual production. As the small unit is identical in design and function to the large mixer, Williamson chemists can follow their manufacturing processes from the pilot plant stage to full scale production and maintain the same standard of quality.

The versatile B-P 100 gallon mixer can handle 500 pound loads of widely dissimilar materials; soft doughs, plastics, heavy viscous semi-liquids or dense, fibrous masses.
With the aid of careful temperature, moisture and operational controls possible with Baker Perkins equipment, Williamson is able to increase capacity, control quality and extend the range of materials which may be processed. The benefits gained with B-P Mixers at Williamson Adhesives, Inc., are proof that BAKER PERKINS Mixers are best. If you have a mixing problem, a Baker Perkins Sales Engineer is a good man to call in.



See our insert in Chemical Engineering Catalog for additional information.

360

BAKER PERKINS INC.

CHEMICAL MACHINERY DIVISION • SAGINAW, MICHIGAN

Walter Linde, North American representative of Gesellschaft fuer Linde's Eismaschinen, points out that by pumping liquid oxygen from near atmospheric pressure and −272 F. to 450 psig. you recover refrigeration at about −200 F. (boiling point of oxygen at 450 psig.) where it's worth less.

True, agrees Air Products. But it's quick to point out that by recovering refrigeration at lower temperature and then compressing oxygen to 450, you'd have to pay a heavy price in compressor-equipment costs. If you make pressurized gas and liquid oxygen on site, Air Products concludes, it makes especially good sense to use pump-cycle such as at Aliquippa.

Other pluses, which Air Products points out, are high purity argon (stream not shown on flowsheet) and nitrogen, which J&L uses in making benzene, toluene and xylene.

One point, however, on which most oxygen makers agree: Every oxygen making plant is a special case.

"In this business," quips one producer, "the only generalization you can make is that there are no generalizations."

New Pilot Unit Turns Out Ultrapure Silicon

Latest entrant in the semiconductor scramble is a new plant recently opened by Westinghouse at Youngwood, Pa., 35 mi. southeast of Pittsburgh.

Products from the new plant will include "both germanium and silicon devices for communications and power applications." However, Westinghouse will place increasing emphasis on power devices because of company's traditional stake in this field.

New plant has a pilot installation which is manufacturing ultrapure silicon with less than one part impurity in six billion parts silicon. Technique being employed is Siemens process, developed by Siemens Schuckertwerke and Siemens-Halske Companies in Germany in conjunction with work done by Westinghouse.

Silicon product goes into new series of transistors and switches handling up to 3 kw. in switching applications.

New Anthraquinone Unit To Use Direct Oxidation

Scheduled to swing on stream next year at Bound Brook, N. J., American Cyanamid's new multimillion-dollar anthraquinone plant will operate via direct oxidation of naphthalene in a fixed bed catalytic converter.

When plant is completed, claims Cyanamid, the firm will be the only commercial producer of anthraquinone in this country. New facilities will also provide additional production capacity for methyl anthraquinone, naphthaquinone and phthalic anhydride.

▶ **Plans Maleic Anhydride Unit**—Too, Cyanamid is slating a 14-million-lb./yr. maleic anhydride plant for completion late next year. New unit will be an outdoor installation and will be designed and built by Scientific Design Co., New York.

New Steps Taken Toward Taming Fusion Reaction

In quick succession last month, U. S. Atomic Energy Commission and British Atomic Energy Authority revealed latest steps in efforts to achieve controlled thermonuclear reaction for peaceful uses.

AEA announced plans to begin construction this summer on a new reactor, unofficially dubbed Zeta II, patterned after Zeta I (*Chem. Eng.*, Feb. 24, 1958, p. 70).

Theoretically, reactor will produce more energy than will be needed to run it. New reactor, its designers say, should be able to heat deuterium to 100 million C., thus making reaction self-sustaining. Estimated cost is about $14 million.

Zeta I is now being modified to up heating capacity to 25 million C.

▶ **U. S. Developments**—AEC described efforts now under way on three possible routes to fusion power in addition to that of pinch effect such as Zeta I uses.

• In stellarators at Princeton University (Model C expected to be operating by 1960), a small current is passed then a larger one is induced by transformer action, bringing the gas to over 1 million C. Further heating is done by shaking the gas with strong alternating magnetic fields. This heating technique is called magnetic pumping.

• At University of California's Radiation Laboratory, Berkeley, Calif. Technique used is known as the mirror approach. Deuterons (with accompanying electrons) are injected into a strong magnetic field provided by two large coils called mirror coils. Thus, the field is shaped like a bottle necked at both ends. Current in the coils is increased to squeeze the gas for greater heating.

• Work at Oak Ridge, Tenn., involves filling a confinement space with superhot ions of energy far above ignition energy. These extremely hot ions of low density have good confinement properties and can be used to heat cooler ions added after hot plasma is formed.

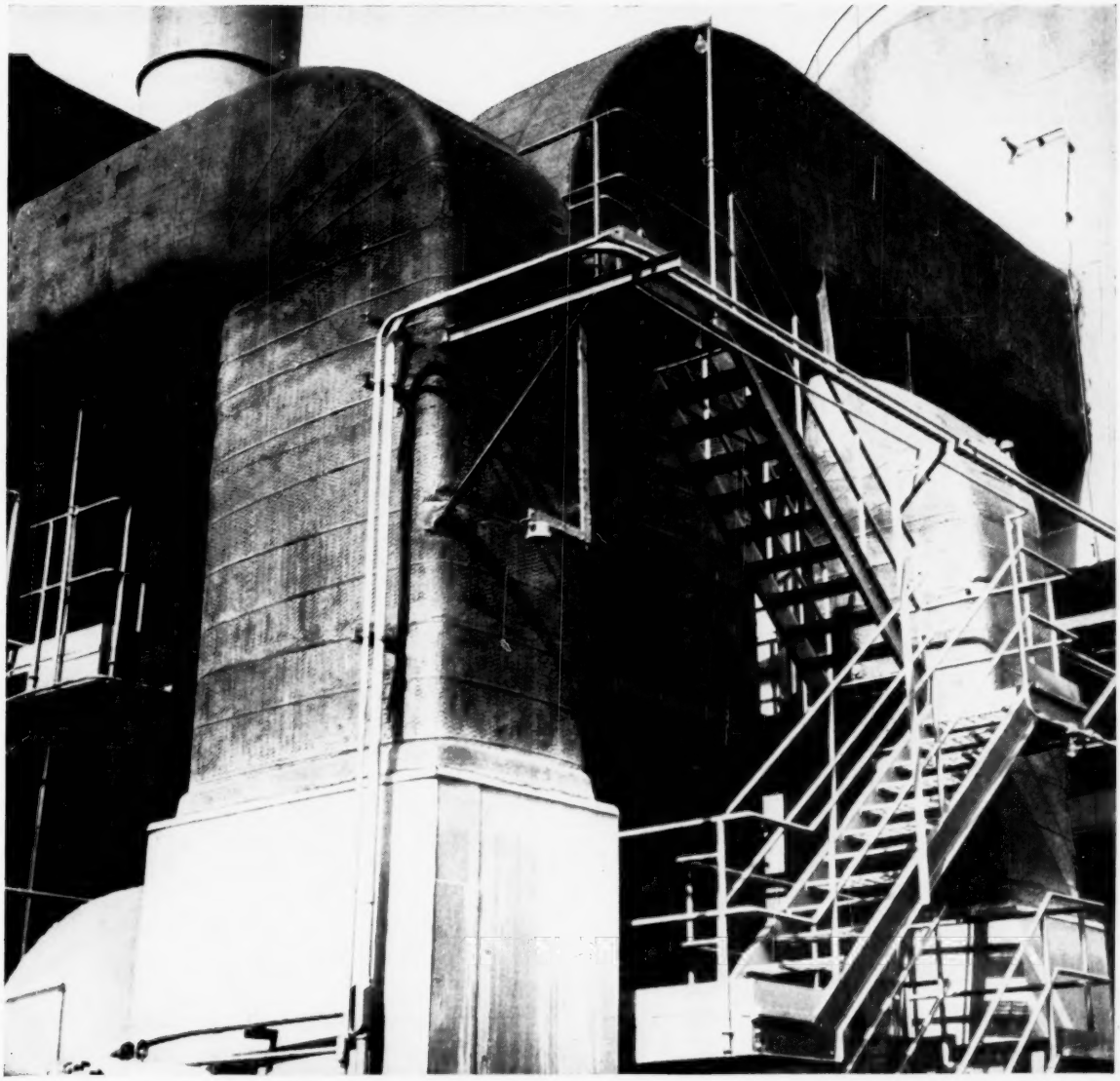
In practice, molecular ions are introduced into the field and dissociate into an atomic ion (deuteron) and an atom of deuterium. Atoms escape but hot ions are caught in magnetic field.

News Briefs

Microcrystalline wax: L. Sonneborn Sons, Inc., has completed a 25% expansion in production capacity of its microcrystalline wax facilities at Petrolia, Pa.

Formaldehyde: Borden Co.'s Mexican affiliate, Industrias Quimicas For-Mex, Mexico City, last month began operation of its $800,000, 20-ton/day formaldehyde plant.

Polyethylene: Carbide Chemicals Co., division of Union Carbide Canada Limited, will boost capacity at its Montreal East polyethylene plant by 12 million lb./yr., has set completion date for April next year.



Corrosive atmosphere of humid salt air makes great demands on such exposed items as insulation netting. Southern chemical producer solves the problem by using Monel hex netting as on this magnesium chloride shelf drier.

Insulation stays up with Monel netting

Hexagon netting of Monel* nickel-copper alloy stays up in spite of corrosive vapors, moisture, acids, alkalies and heat that cause other materials to fail.

And just take a closer look at the photo . . . notice how the pliability of ductile Monel alloy helps it fit snug around insulation? It's strong as structural steel! This close-fitting support prevents flaking and peel-off . . . keeps insulation in service longer.

Here's proof of performance: insulation put up with Monel alloy netting has now been in service for over 12 years. Many plants show cuts of up to 50% in annual cost of maintaining insulation, by using Monel.

Next time you insulate, use Monel hexagon netting – available from Gilbert & Bennett, Georgetown, Conn. They'll be glad to fill in all details... supply you with samples and prices.

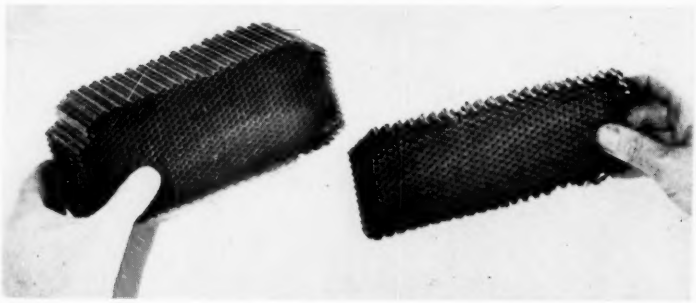
*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO

INCO NICKEL ALLOYS

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



PHENOLIC impregnated honeycomb cores for aircraft stand 500-600 F.

Phenolics Beat Aircraft Heats

Several phenolics, one brand new, are among best weapons against heat barrier of supersonic flight.

Glass fiber laminates made with a new phenolic resin will retain their high strength at 500 to 600 F. Only existing commercial phenolics claiming this kind of heat-strength are a group developed by Cincinnati Testing & Research Laboratories which some missile experts have regarded as the best thing the U. S. has developed for overcoming the heat barrier encountered in supersonic flights.

Called Plaskon V-204, the new phenolic was developed by Barrett Div. After 100 hrs. at 500 F., its laminates retain more strength than that demanded for room temperature conditions in military specifications for finished laminates for heat resistant applications. For example, ultimate flexural, flat-wise strength of the new phenolic in a glass fiber laminate is 80,000 psi.; military specification is 50,000. After 100 hrs. at 500 F., product strength is 59,000; military requirement is 20,000 psi.

It follows that the laminates will retain considerable strength for a useful amount of time at 600 F. Outside of Barrett's and CTRL's, the best phenolics lose useful strength after two or three minutes at 600 F.—**Barrett Div., New York, N. Y.** 72A

Some parts like honeycomb wing cores, laminated heat barriers and electronic housing, and ducting in newer aircraft such as Convair's B-58 must right now be able to withstand ambient temperatures in the 500-600 F. range. This is where these phenolics come in. In the past, polyester-styrene type resins, limited to service below 350 F., and lower-temperature phenolic products have been satisfactory in these applications.

CTRL's high-temperature products include a phenolic called 91-LD, on the market for several years, and a new resin called 37-9X described as a phenyl silane copolymer. Company suggests the former for service in the 500 F. range and the latter for performance in the 500 to 1,000 F. range.

However, 91-LD is the phenolic used in Astrolite, a silica-reinforced phenolic said to resist 10,000 F. for short one-shot uses like ICBM nose cones (*Chem. Eng.*, Jan. 27, 1958, p. 74).

U. S. Polymeric Chemicals Inc., Stamford, Conn., and American Reinforced Plastics Co., Los Angeles, are licensed to handle CTRL products.—**Cincinnati Testing & Research Laboratories, Cincinnati, Ohio.** 72B

Amines

New raw material for textile resins, textile softeners.

Two new amines, 1,3-diaminopropane and imino-bis-propylamine, are now available commercially.

The first, a water-white liquid which is completely soluble in water and common organic solvents, is a raw material for textile crease-resistant resins with improved scorch-resistance.

Imino-bis-propylamine is expected to be of particular value as a raw material in the production of textile softeners, paper-treating resins, and ion exchange resins. It is a colorless, high-boiling liquid which is completely soluble in water and common organic solvents.—**Union Carbide Chemicals Co., New York, N. Y.** 72C

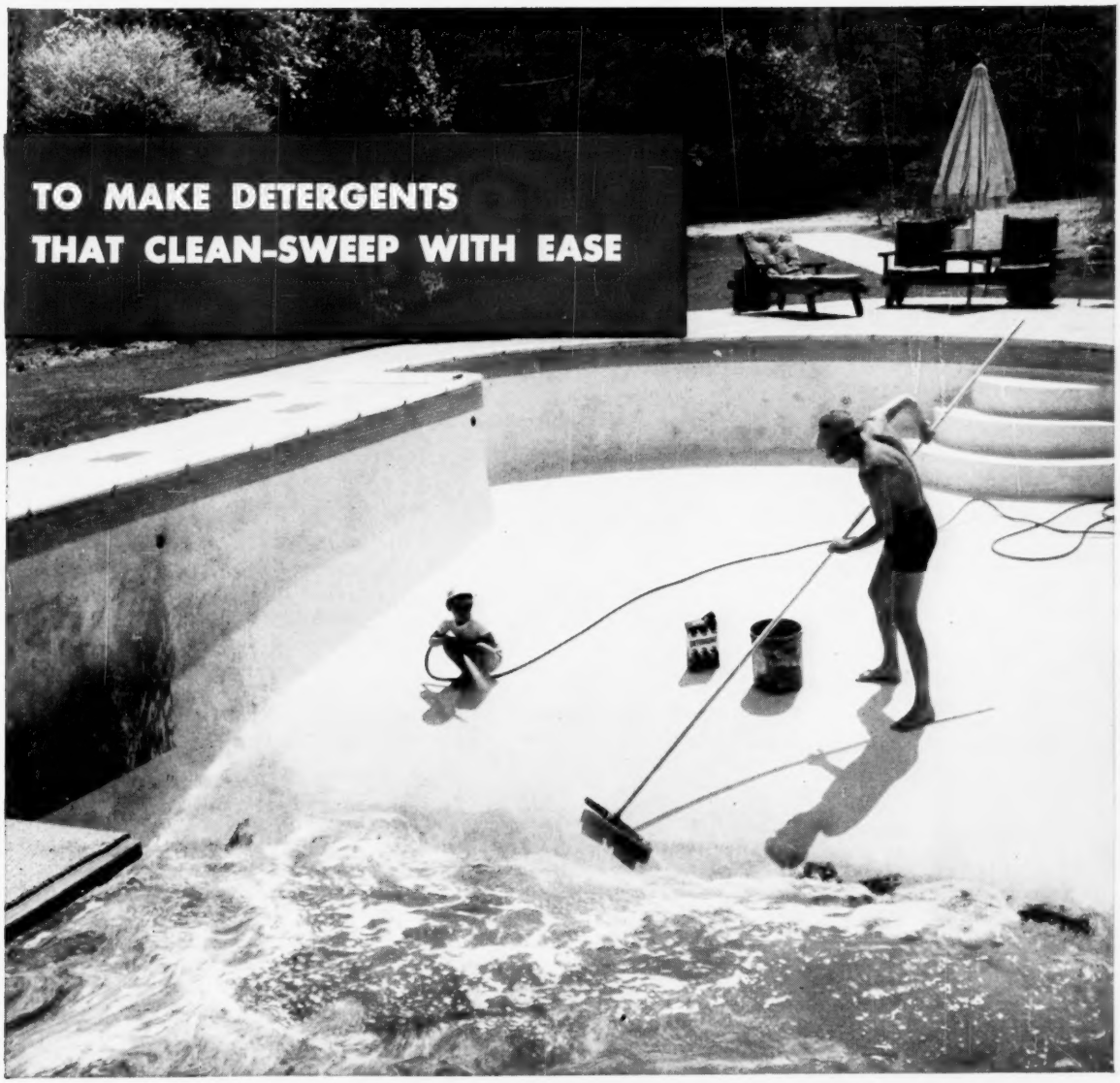
Rayon Tire Cord

About 50% stronger than previous tire cords.

American Viscose will convert its entire tire yarn spinning capacity to a new stronger and lighter weight rayon yarn. The new yarn is 1100 denier and is about 50% stronger than previous type cords with a fatigue improvement several times that amount. Avisco's previous tire cord was 1650 denier.

Cost is about 63¢/lb. compared to 58¢ for standard types, but it is considerably less than nylon.—**American Viscose Co., Philadelphia, Pa.** 72D

Industrial Rayon Corp., too, has developed a stronger tire cord—described as 50% stronger than those produced six years ago. It is in limited production. — **Industrial Rayon Corp., Cleveland, Ohio.** 72E



ENJAY OLEFINS

- **TETRAPROPYLENE**
- **TRIPROPYLENE**

When you manufacture detergents, be sure you use the best raw materials. Use Enjay Olefins—Tetrapropylene and Tripropylene. These Enjay raw materials are useful not only for detergents but also in many other industrial applications.

Enjay Olefins—like all Enjay petrochemicals—are known throughout industry for their uniform purity and high quality. Remember—for top-quality dependable detergents, use Enjay Tetrapropylene and Tripropylene. The Enjay Company offers a complete line of petrochemicals for industrial use.

ENJAY

Pioneer in Petrochemicals

FOR COMPLETE INFORMATION on specifications and characteristics of these and many other high-quality petrochemicals, contact the nearest Enjay office. Shipments will be made from conveniently located distribution points in tank car, truck or 55 gal. drum quantities.

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
Other Offices: Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

Plastic Film

Vinyl fluoride based; promising for outdoor use.

A plastic film with superior outdoor weathering characteristics is now available in sample quantities.

Called Type R film, it is based on a new polymer. The predominant monomer is vinyl fluoride. Polymers of this type are covered by U. S. Patent 2,419,010. Patent applications have been filed relating to processes for making it though no decision has as yet been made to undertake commercial production.

An early laboratory sample, after ten years exposure to the elements in Florida, has not discolored or become brittle. The film is clear and colorless, with good transparency. It has high mechanical strength, excellent resistance to chemicals, transmits ultraviolet light and retains its properties through a wide temperature range.—**Du Pont Co., Wilmington, Del.** 74A

Ceramic-Coated Wire

Flexible, retains dielectric, protective properties to 1,000 F.

News of the development of similar types of flexible, highly heat resistant ceramic-coated copper wire has come from two sources in recent weeks.

One, called Ceramicite, will be produced commercially by Sequoia Wire & Cable Co. and Hitemp Wires, Inc.

Ceramicite coatings include a number of different ceramic compositions that withstand continuous operation at temperatures to 1,000 F. They can also be used to bond electronic components that must withstand extreme environmental conditions. Developer is Consolidated Electrodynamics Corp.—**Consolidated Electrodynamics Corp., Pasadena, Calif.** 74B

The other product was developed by Battelle Memorial Inst. and General Electric's Fort Wayne, Ind., laboratory. The coating is a special porcelain enamel, applied in a continuous process. The coated wire is flexible and the coating retains its dielectric and protective properties at temperatures higher than do present organic coatings. It is now undergoing pilot plant study.—**General Electric Co., Fort Wayne, Ind.** 74C

Ultraviolet Absorber

Chemical prevent light degradation of absorbents.

Discoloration, embrittlement or other degradation caused in many organic materials by exposure to ultraviolet light is said to be reduced or prevented entirely by new UV 9 Ultraviolet Absorber.

Chemically, 2-hydroxy-4-methoxybenzophenone, it absorbs ultraviolet light throughout a wide range of ultraviolet wavelengths. Plastics manufacturers have found that only a fraction of a percent is necessary.

It is already being used in polyesters, polystyrene fluorescent light louvres, vinyl seat covers, shower curtains, garden hose and rear windows of convertibles. It has high stability to heat and does not affect the color or clarity or resins during processing or fabrication.—**American Cyanamid Co., New York, N. Y.** 74D

Diepoxides

To function as diluents in epoxy and other resin systems.

Available for the first time are two diepoxides: dicyclopentadiene dioxide and limonene dioxide. They combine the reactivity of the epoxy group with their bifunctional nature, are expected to find their principal use as constituents in epoxy and other resin systems where they can function as diluents, crosslinking agents, or modifiers of resin properties.

Other applications for the new diepoxides are as intermediates in the preparation of perfumeries, cosmetics, pharmaceuticals, pesticides, protective coatings, plasticizers, adhesives, lubricants and lubricant additives and in organic synthesis.—**Becco Chemical Div., Buffalo, N. Y.** 74E

Grease

Combines advantages of many different greases in one product.

New Mobilplex EP (for Extreme Pressure) grease is said to effect saving for industrial plants because it can be used in many different machines in place of a variety of special-purpose greases.

Light tan in color, it is a calcium-EP-complex grease said to withstand extreme pressures, to have long service life, to be water resistant and at the same time to maintain chemical stability despite temperatures from −15 to 300 F.—**Socony Mobil Oil Co., New York, N. Y.** 74F

BRIEFS

Primary aliphatic amines, the first of a series of fatty nitrogen chemicals, are now in semi-commercial production. They are expected to find use in surface active agents, ore flotation, corrosion inhibition, rubber compounding, textile auxiliaries and as chemical intermediates.—**Archer Daniels-Midland Co., Wyandotte, Mich.** 74G

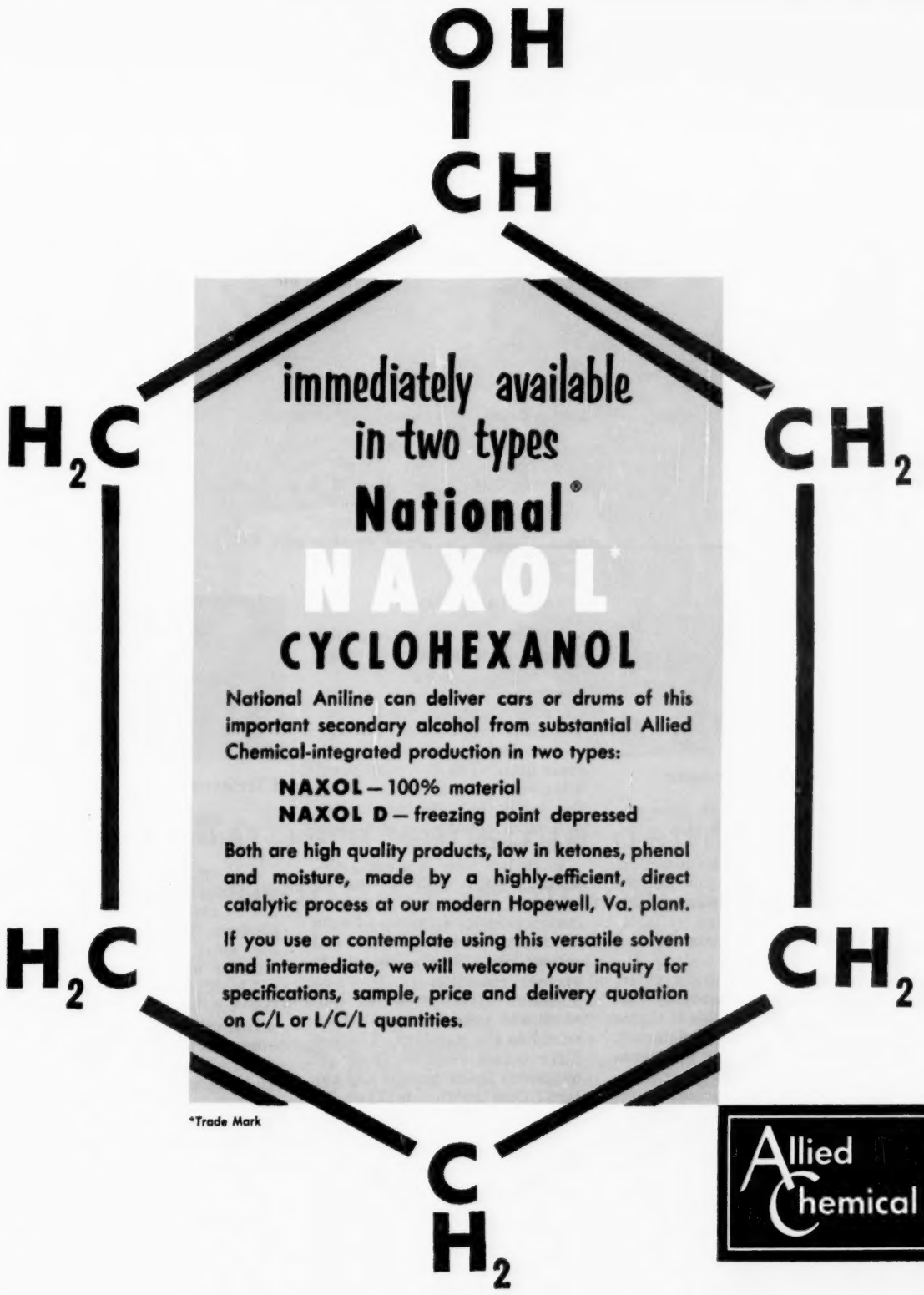
Nickel-promoted cobalt-molybdenum catalyst on a special low density alumina base has been developed. Called Nicomo 1, it aims at meeting demands of the petroleum industry for a highly active, long-lived, economical and rugged product for catalytic hydrogen processing. It is now commercially produced as ⅛-in. extrusions by a unique process which insures availability of the entire catalyst surface to the reactant streams.—**Davison Chemical Co., Baltimore, Md.** 74H

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 225)



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National Aniline can deliver cars or drums of this important secondary alcohol from substantial Allied Chemical-integrated production in two types:

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Both are high quality products, low in ketones, phenol and moisture, made by a highly-efficient, direct catalytic process at our modern Hopewell, Va. plant.

If you use or contemplate using this versatile solvent and intermediate, we will welcome your inquiry for specifications, sample, price and delivery quotation on C/L or L/C/L quantities.

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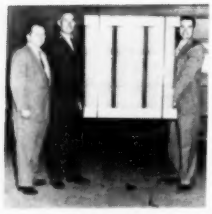
DEVELOPMENTS ...

PROCESS EQUIPMENT

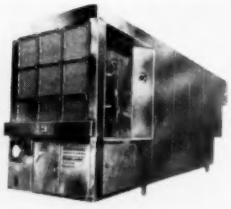
EDITED BY C. C. VAN SOYE

Current Developments Lineup



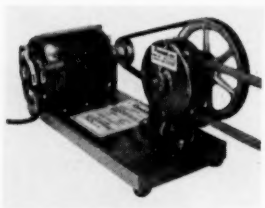
Pail Unitizer

Slashes handling time, stops pail damage, ups stack height. 80D



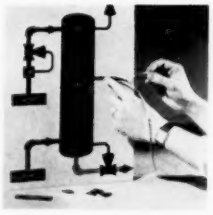
Horizontal Spray Dryer

Manufacturer pre-assembles and pre-tests package; installs quickly. 80A



Squeegee Pump

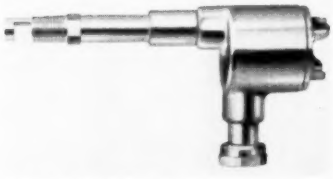
If flexible tubing can contain a given liquid, pump can move the liquid. 80C



Panel Symbols

Plastic symbols cut new board costs; aid process change. 82A

Page number also Reader Service Code number



Liquid-Level Sensor

Uses radiation to give accuracy of ±0.05 in.

Modern radiation-detection techniques endow the unique Betatrol liquid-level sensor with extreme accuracy and reliability, even with viscous liquids, acids and alkalis.

Containing no moving parts, the detection probe consists of a permanently sealed beta-source and a radiation detector. The two components are separated by a gap open to the liquid. Accessories include a remote printed-circuit amplifier.

In operation, beta rays from the source pass across the gap to the detector. Intensity of radiation at the detector depends on whether liquid fills gap.

The probe functions normally at temperatures from −65 to 220 F., and pressures from vacuum to 800 psig. Beta source half-life is 28 yr.—**Robertshaw-Fulton Controls Co., North Manchester, Anaheim, Calif. 76A**

Pilot-Plant Filter

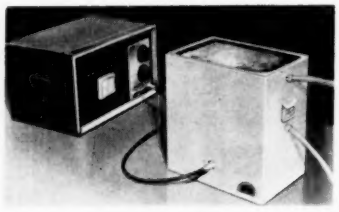
Universal filter stations available on rental basis.

A recently introduced universal pilot-plant filter helps you determine optimum filtering factors before ordering a full-scale filter. The K-S pilot-plant filter station enables you to do this with your own production personnel under your own plant conditions.

Each K-S unit is a complete-package filter designed for all vacuum applications. Special design permits all types of cake discharge—string, scraper and roller; the unit also adapts to precoat operation.

Either spray wash or belt wash and cake compression assemblies are standard. The K-S filter comes complete with all accessory tanks, pumps and motors. Construction is Type 316 stainless steel throughout. Drum speed is variable from 0.075 to 2.29 rpm.

Units are available on a nominal monthly rental basis. Part of the rent is applicable as a credit allowance against purchase price of full-size filters. Or if desired, the pilot plant equipment may be purchased outright. — **Komline-Sanderson Engineering Corp., Industrial Filter Div., Peapack, N. J. 76B**



Ultrasonic Degasser

Continuously removes dissolved gases from liquids.

A new ultrasonic machine continuously degasses feed liquid to give essentially gas-free product. The machine will handle most clear liquids, light slurries and emulsions.

Liquid to be degassed enters the top of the stainless steel ultrasonic tank via a small pipe connection. High-energy ultrasonic vibration impels dissolved and occluded gas upward and out of the system. Degassed liquid flows out bottom of the chamber, just above the transducers.

The degasser comes complete with a rugged 20,000 cps. electronic generator. Flow capacity for complete degassing varies up to 5 gpm., depending on liquid viscosity.—**The General Ultrasonics Co., 67 Mulberry St., Hartford 3, Conn. 76C**

(Continued on page 80)

ONE OF A SERIES

Printed by offset lithography on 70-lb. paper containing Wyandotte PURECAL® in the coating.

What is a sensible definition of Wyandotte's technical service?

Well, you won't find it in a dictionary.

And you'll be far short of the truth if you decide it's just the name of a department.

Really, it comes down to this: At Wyandotte, technical service means a deep-rooted and sincere desire to be helpful. Any time . . . any place . . . in any way we can. It's a philosophy of doing business that's shared by every man in our organization.

For instance, we are always ready to supply you with information on our products—on their chemical and physical properties along with other pertinent characteristics. We'll suggest ways to handle and store them; and we'll dig deep for data on their specifications and use limitations.

Naturally, our science-specialists* are at your disposal, too—ready to consult with your researchers on any problem that may suggest the use of one or more of our products. (In several cases, this type of consultation has led us to develop an entirely new product designed to solve the customer's problem!)

Helpful? . . . well, most of our clients have found it so. And that's why we, at Wyandotte, give technical service such a broad definition.

If you would like to take advantage of this service, just send us all the background information you can on your product or processing problem. We'll be happy to work with you.

For a pictorial presentation of Wyandotte at work, turn the page.

*Chemists, chemical engineers, physicists, etc., whose industrial or research experience qualifies them as specialists in their particular field.

WYANDOTTE CHEMICALS

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE
GLYCOLS • SYNTHETIC DETERGENTS (anionic and nonionic) • CARBOSE® (Sodium CMC) • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • PROPYLENE OXIDE • PROPYLENE
DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

Assisting at the birth of a new product

. . . an example of Wyandotte technical service at work

1 "We are developing a new product," a typical inquiry begins, "and are looking for a surface-active agent with dispersing properties superior to those presently on the market." Enclosed was full information.

2 With the need for a new raw material established, background data are withdrawn from Wyandotte's files as a basis for studying problems inherent in producing it.

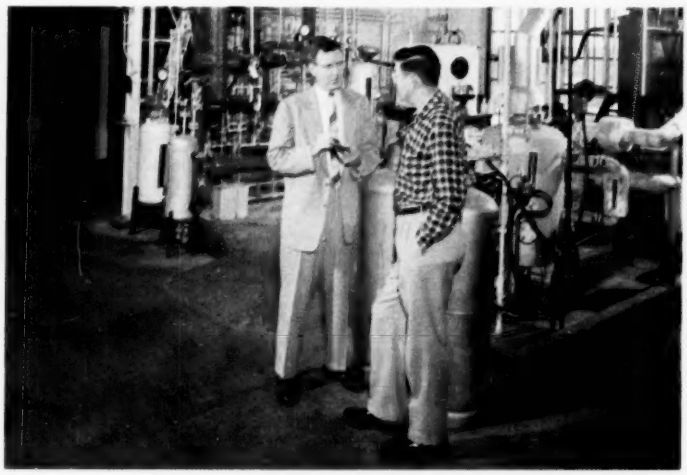
3 Teamwork: There's a meeting between members of research, production, and sales departments to determine feasibility of entering into new-product production.

4 After our research tests confirm Wyandotte's laboratory candidate as the proper raw material, technical-service man requests prospect's further evaluation and confirmation. He further discusses volume requirements, potential growth.

Wyandotte technical service may show up in the birth of a product, improvement of existing materials, development of new applications or procedures. It's a continuing activity. For, everyone at Wyandotte not concerned with routine administration or production is devoted to helping customers use our chemicals most effectively. If you have a problem within our technological background, check with us . . . our approach is designed to provide answers. *Wyandotte Chemicals Corporation, Michigan Alkali Division, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte CHEMICALS

Pacing progress with creative chemistry

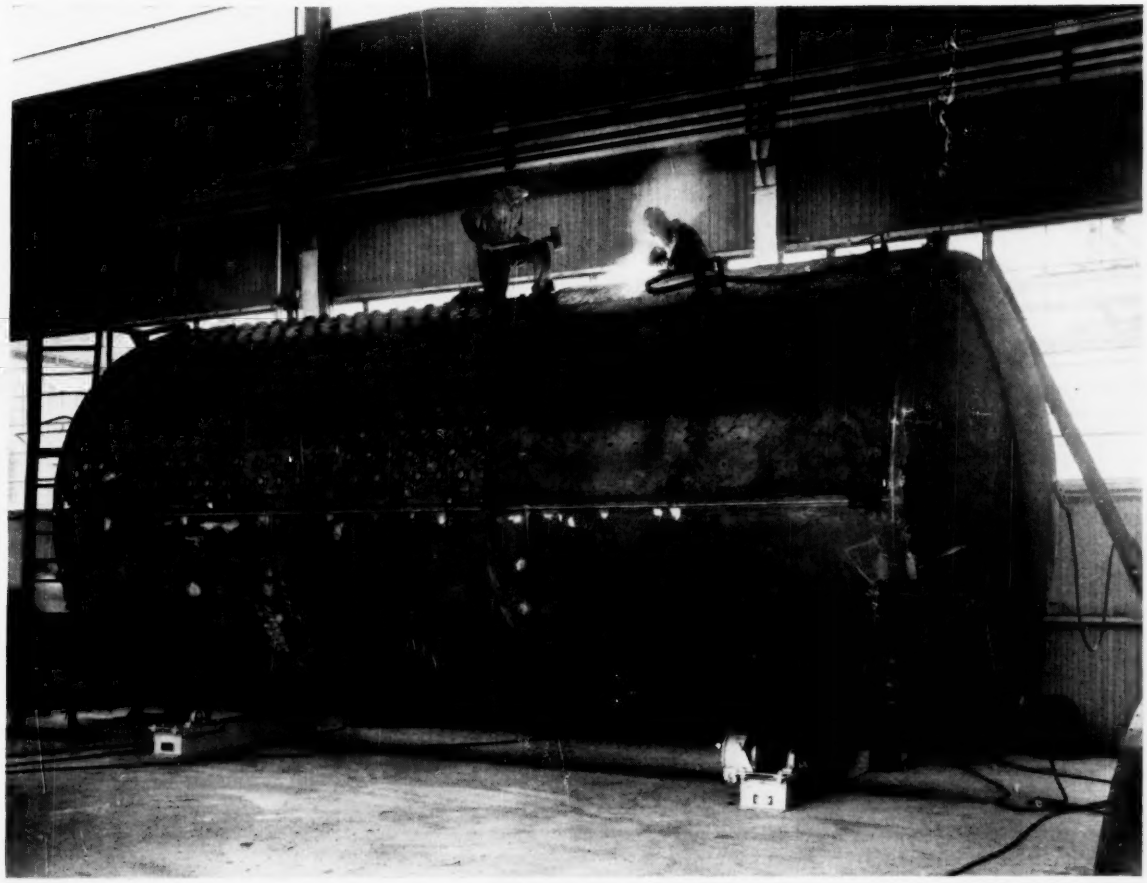


5 New product shows important, growing market. Before full-scale commercial manufacture of the raw material is started, details of production are worked out in Wyandotte's pilot plant. This step, taken with all new products, assures manufacture is possible on a volume basis at a practical cost.

6 Technical-service man draws up final physical and chemical specifications prior to shipment. Samples of pilot-plant production are taken to the prospect for final evaluation.

7 Raw material is approved, and arrangements are made with the customer for initial shipment by technical-service man and representative who will service the account.

MTB Fabrication Fact Sheet



Hot Solution To A Storage Problem

A chemical manufacturer had a problem.

A liquid chemical had to be stored while awaiting truck and tank car pickup. Also, at normal temperatures it was impossible to keep the chemical from "salting out".

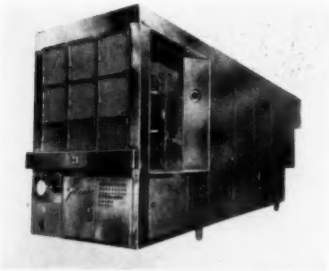
They needed a storage tank which would eliminate this problem. Missouri Boiler provided the answer in this 12'0" O.D. x 28'0" long Jacketed Tank. This vessel was designed for an external pressure of 125 p.s.i. @ 350°F. To solve the "salting out" problem the bottom 120° was steam jacketed using 788 stays welded to the tank and plug welded to the jacket. These stays were used to stiffen the shell to withstand the external pressure. The completed vessel was installed and the problem was solved.

Missouri Boiler has the experience and skill to custom fabricate to your needs. May we suggest that you add us to your bidder's list for steel and alloy plate fabrication from ¼" to 1¼". We think you'll be pleased with our better prices and dependable deliveries.

MISSOURI BOILER AND TANK COMPANY

Formerly Missouri Boiler and Sheet Iron Works

2218 Papin Street **St. Louis, Missouri**



Horizontal Spray Dryer

Continuously assures a high-uniformity product.

A new, horizontal spray dryer comes as a complete package—controls, burners, auxiliaries, electrical work — all factory-assembled and tested. Available in three different series, with over-all capacity ranging from 500-6,000 lb./hr., the dryers feature stainless-steel construction, inside and out.

In operation, currents of temperature-controlled air carry the spray-atomized particles of product straight through the dryer. Streams of warm air buoy-up heavier particles that tend to drop out. Drying cycle for all particles is just 7 sec.

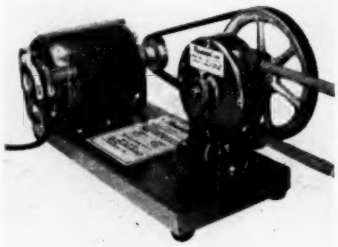
A special vertical packaged dryer is also available.—**Henszey Co., Watertown, Wis.** 80A

Temperature Controller

Transistorized system features high versatility.

Consisting of a compact transistorized amplifier that serves as the temperature controller, and a vibration-proof mounting containing a thermistor sensing element, the R7079A will control air, surface or immersion temperatures. One amplifier relay serves either of a variety of the heat-sensing units.

Available in eight overlapping ranges of about 100 deg. each, the amplifier relays permit control from −60 to 520 F. Thermistor and amplifier may be located as much as 2 mi. apart.—**Minneapolis-Honeywell, Control Device Div., 2747 South 4th Ave., Minneapolis, Minn.** 80B



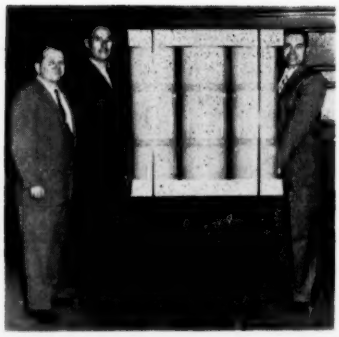
Squeegee Pump

Handles corrosives and abrasive slurries easily.

The new Randolph pump offers a pumping capability for an almost universal assortment of solutions and slurries. No moving parts contact the fluid being pumped.

Intake and outlet consist of one, continuous, flexible tube that passes through the pump body. Within the pump, a double rotor moves liquids through the tube with a gentle squeegee or kneading action.

The unit will handle any liquid for which there is a flexible tubing of suitable chemical and wear resistance. Available in several sizes, maximum capacity at 5 psi. is about 4 gpm., and at 20 psi. about 2½ gpm.—**Palo Laboratory Supplies, Inc., 81 Reade St., N. Y., N. Y.** 80C



Pail Unitizer

Saves 90% handling time per carload of pails.

A new way to pack empty steel pails for shipment cuts unloading time per freightcar load from 21½ to 2½ man-hr., according to the manufacturer. Called Handy-Pak, the pail-package also helps preserve the appearance of pails by protecting them against scuffing and other damage.

Each Handy-Pak unitizes 27 pails, stacked in three layers of nine pails each. Corrugated-board caps cover the top and bottom of the stack; steel straps hold the entire assembly firm.—**Bennett Industries, Inc., Peotone, Ill.** 80D

Fork Truck

Facilitates handling in narrow aisles.

Ability to handle extra-long loads in narrow aisles is an example of the versatility of Raymond's four-directional fork truck. The new truck is capable of traveling sideways to the right or left, as well as forward and backward.

A special arrangement of the load wheels imparts this ability. One of them, controlled by a driver-operated hydraulic system, turns either forward or 90 deg. to the right. The other load wheel is a free-swiveling caster.

The four-directional design comes in several different models similar to the company's standard fork truck lines. Capacities vary accordingly.—**The Raymond Corp., 272-159 Madison Ave., Greene, N. Y.** 80E

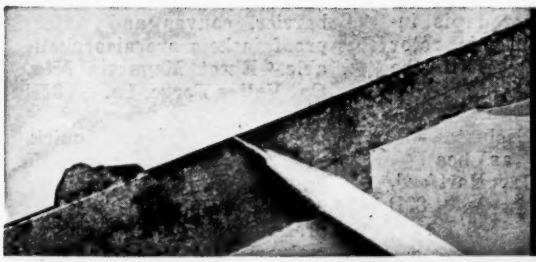
Equipment Cost Indexes

	Dec. 1957	March 1958
Industry		
Avg. of all	229.2	231.2
Process Industries		
Cement mfg	220.7	222.9
Chemical	230.4	232.4
Clay products	214.4	216.6
Glass mfg	217.6	219.4
Paint mfg	221.6	223.8
Paper mfg	222.0	223.9
Petroleum ind	226.3	228.6
Rubber ind	229.1	231.4
Process ind. avg	227.0	228.8
Related Industries		
Elec. power equip	232.9	234.2
Mining, milling	231.8	233.8
Refrigerating	258.9	261.5
Steam power	216.9	219.5

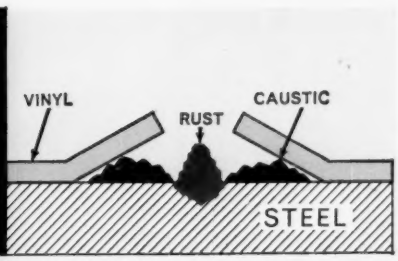
Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124—6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143—4 for annual average since 1913.

PUZZLED ABOUT PRIMERS?

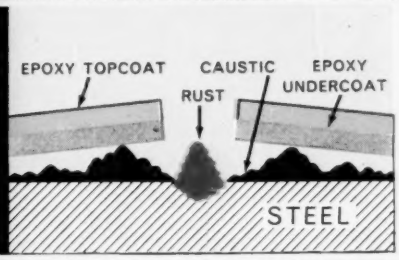
Here are tests you can duplicate

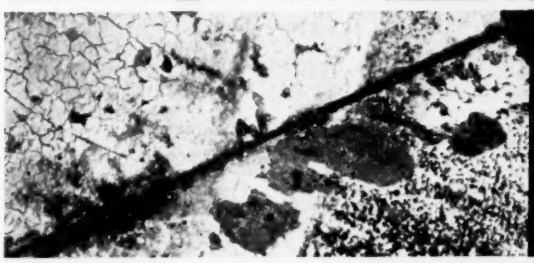


TEST 1—One coat of self-priming vinyl. Coating breaks away (L) due to severe undercutting (R), exposing metal to progressive corrosion.

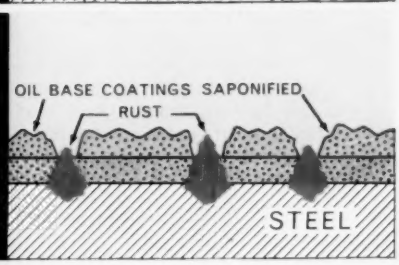


TEST 2—Epoxy primer, epoxy topcoat. Coating lifts off in single sheet (L) as adhesion fails (R), exposing entire surface to corrosion.

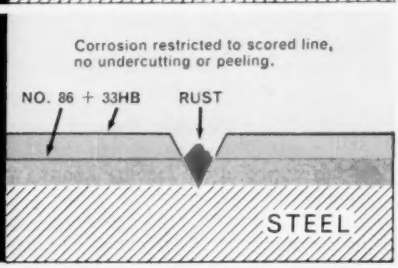




TEST 3—Oil primer, oil topcoat. Both coats fail completely (L) as underfilm caustic reacts on their oils to form soaps (R).



TEST 4—Amercoat's No. 86 inhibitive primer and No. 33HB vinyl topcoat. Corrosion restricted to scored line (L), no undercutting or peeling (R).



The purpose of these accelerated tests is to show what happens when various types of coatings are exposed to a typical corrosive environment. Four clean steel panels, free from mill scale and rust, were coated with different combinations of primers and topcoats. Each was scribed to bare metal and immersed in salt water in the presence of free oxygen, for two weeks.

As caustic deposits formed over cathodic areas of the steel in tests 1, 2 and 3, failure occurred in three ways. The vinyl, though not directly attacked, was undercut as caustic spread beneath the film and destroyed adhesion. The epoxy coating, known for critical adhesion to smooth metal, proved impervious to caustic attack. It was, however, lifted in its entirety as moisture spread beneath the surface. The entire oil paint film was quickly penetrated by the salt solution, creating widespread corrosion and caustic formation. The caustic then reacted with the oil to saponify the film.

In the fourth test the corrosion was limited to the score mark. Reason: Amercoat No. 86 Primer resists undercutting and adheres tenaciously, inhibiting electrolytic corrosive action.

The conclusions are clear. To provide long term protection in corrosive service, start with Amercoat No. 86 Primer, which provides a sound and lasting base for quality topcoats such as Amercoat No. 33HB.

Write today for complete data on Amercoat No. 86, and have the details on hand when planning your next important coating job.

Amercoat CORPORATION

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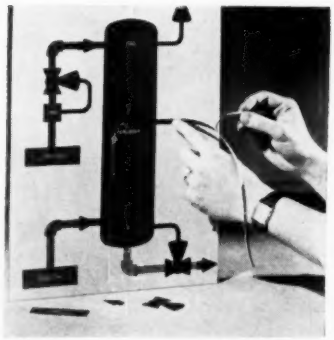


Panel-Board Symbols

Cut manufacturing cost of control boards.

Panel boards built by Panellit, Inc., now utilize pressure-sensitive graphic symbols made of Mylar plastic. The company claims that this technique results in a 15-25% reduction in panel-board cost.

Coming in a wide range of colors, the symbols are available in kit-form for field modification of existing boards to conform with process changes. — **Panellit, Inc., 7401 North Hamlin Ave., Skokie, Ill. 82A**

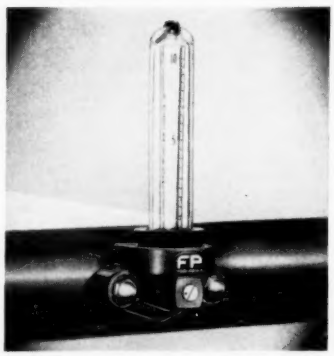
Magnetic Drive

Provides cushioned starts, protects motor.

The Whitney-Tormag magnetic drive, brought to the U. S. for prototype testing about two years ago, is now commercially available in a range from 1 to 15 hp. Acting as a slip-type safety device between motor and driven member, the drive provides for smooth, cushioned starts with high efficiency of power transfer.

Two rotors, mounted with an air gap between them, comprise the protective element. The bimetallic driving rotor, which always rotates at motor speed, is a copper-faced mild steel cylinder perforated with steel rivets. The driven rotor, also called the magnetic rotor, is a steel cylinder having strong Alnico V permanent magnets attached around its periphery. Driving and driven rotors never come in contact.

Operation of the drive depends on inter-rotor drag forces. For example, during motor starts, a torque is induced in the magnetic rotor through eddy currents, with the permanent magnets supplying necessary magnetic flux. The bimetallic rotor dissipates unused horsepower as heat. — **Whitney Chain Co., Hartford, Conn. 82B**



Flowmeter

Suitable for services with flow ranges up to 10:1.

The Mighty-I measures flow in either direction and in any pipe size from 1½ to 8 in. without the use of additional accessories.

Easily installed on any line in a matter of minutes, the new corrosion-resistant meter requires no flanges or matching orifice plates. Scales for the ball float come in 3 to 30-gpm. and 200 to 2,000-gpm. sizes.— **Fischer & Porter Co., 677 Jacksonville Rd., Hatboro, Pa. 82C**

BRIEFS

TV camera, closed circuit Type TE-6A, is a self-contained unit that is easy to install and service. Can be easily adapted to applications calling for remote control or interlace scanning. — **General Electric Co., Electronics Park, Syracuse, N. Y. 82D**

Glass-fiber insulation, available in 3-ft. sections hinged to open and close around pipe, has low thermal loss, light weight and long life. Vapor-barrier, canvas and waterproof jackets are also available.—**Ehret Magnesia Mfg. Co., Valley Forge, Pa. 82E**

Swing-gate valve gives quick, absolutely tight flow shut-off under pressures as high as 500 psi. A plastic lubricant, pressurized by a screw piston, maintains the leak-proof seal. — **W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn. 82F**

Load-control system, consisting of a U. S. Varidrive with Varitrol automatic control, maintains work loads on grinding mills and similar equipment within 10% of desired value. — **U. S. Electrical Motors, Inc., Box 2058 Terminal Annex, Los Angeles, Calif. 82G**

Zone-melting apparatus, reported to be the only commercially available model, comes ready for production or study of pure materials and semiconductor devices.—**Research Specialties Co., 2005 Hopkins St., Berkeley 7, Calif. 82H**

Cool-gas generator provides gas with temperatures controllable from −25 F. to 1,800 F. at pressures to 2,000 psi. Generated gas is suitable for driving power systems, turboblowers. — **McCormick Selph Assoc., Hollister, Calif. 82I**

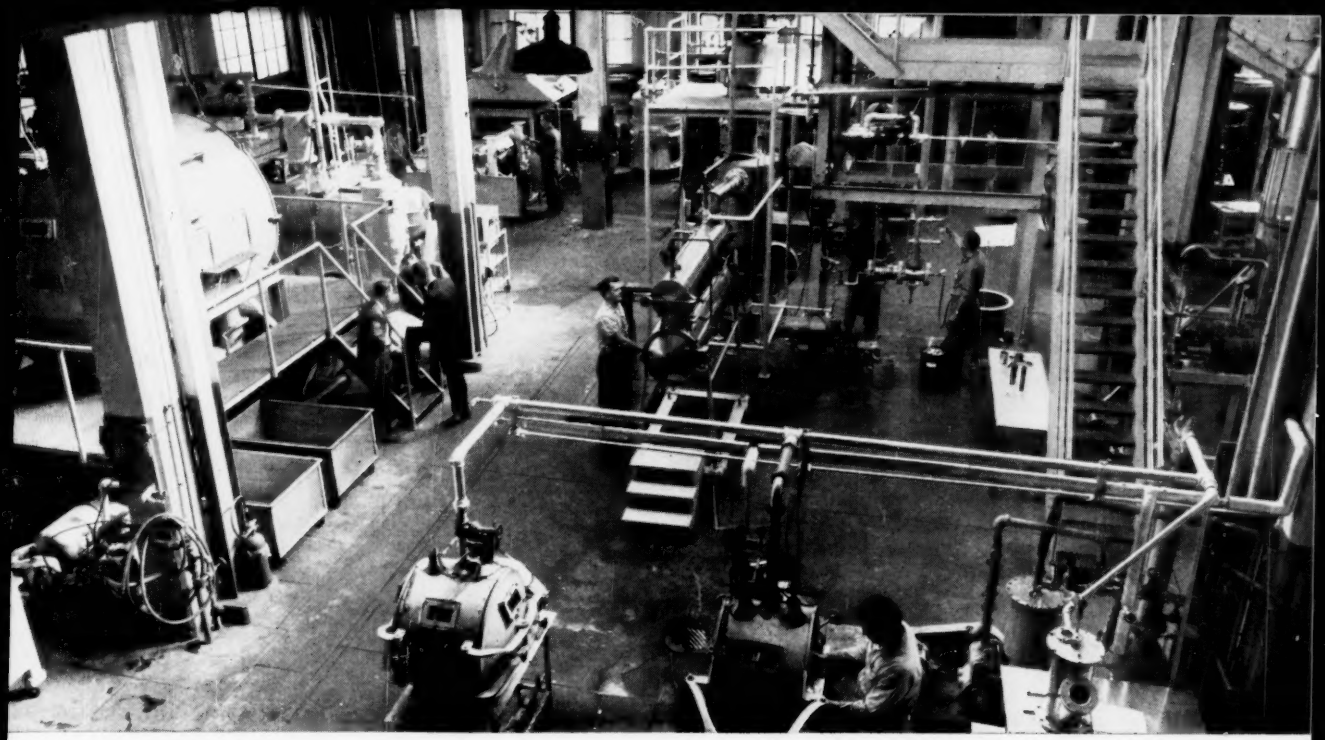
Odor eliminator electronically removes objectionable odors from the air at their source. Operating off a 110-v. supply, units also permit deodorizing of air-conditioning systems.— **American Electroaire Co., 260 Tremont, Boston, Mass. 82J**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 225)



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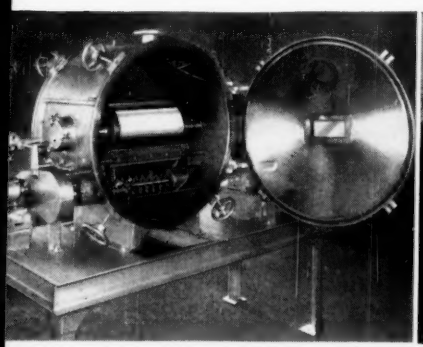

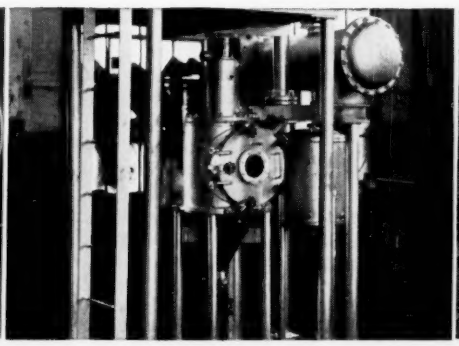

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Rubber Chemicals: Growth With Stability

- Growth from **growth of the rubber industry**—about 2% a year, **12% greater by 1963.**
- Growth from **increasing use of synthetics**—63% of today's rubber, **68% by 1963.**
- Growth from **needs for new chemicals**—non-staining agents, delayed-action accelerators, antiozonants.
- Stability from **broadening non-tire outlets** for rubber—38% in 1958, **45% by 1963.**

Trends in Rubber Chemicals

Frances Arne, Assistant Editor

Markets for rubber chemicals —chemicals used to help prepare polymers (we exclude the chemical monomers, themselves) or to help fabricate rubber products —show solid, but not sensational, growth.

They grow with the growth in rubber consumption—only 2-3% a year—and the continuing, albeit slowing, shift to synthetics which call for more chemicals than does natural rubber. They grow and change (especially the latter) with the birth and growth of new breeds of polymer and new demands on established rubbers.

And, underlying the growth pattern, there is more stability. Protection against fickle swings in auto sales is strengthening as non-tire outlets for rubber—now better than half of sales—account for more and more of total consumption.

▶ **Hand in Hand**—Consumption of new rubber in the U.S. during 1957 established it as the second highest year on record: 1,467,506 long tons, up from 1,436,482 long tons in 1956. All-time high was 1,529,699 long tons in 1955.

Here's how chemical suppliers to the rubber industry have also benefited. For every 100 parts of rubber, there are 1-2 parts antioxidants, 0.5-1.5 parts accelerators, 0.1-1.5 parts peptizers. Latest government figures on consumption of these three was the 132 million-lb. total reported for 1956, which undoubtedly rose last year in proportion to rubber's 1957 rise.

This year should at least equal 1957, if only on the basis of replacement tire sales for autos bought during the 1955 peak.

▶ **Bigger Chemical Appetite**—A factor contributing to added gain in consumption of rubber-processing chemicals is the tendency to use more synthetic rubber. The average synthetic rubber compound takes about 1.75 times as much rubber chemicals as the average natural rubber compound.

Of the total new rubber consumed in 1956, synthetics amounted to 60.9%. The 1957 share was 63.3%. This share will continue to grow because supply of natural rubber cannot increase substantially in the next five years.

Another trend is increasingly affecting the market for rubber chemicals and rubber itself—this time in the direction of stability. Non-tire uses, which are not subject to erratic year-to-year fluctuations of automobile sales, have grown at a rate of 1%/yr. for the past ten years, will reach an estimated 38% of total consumption in 1958.

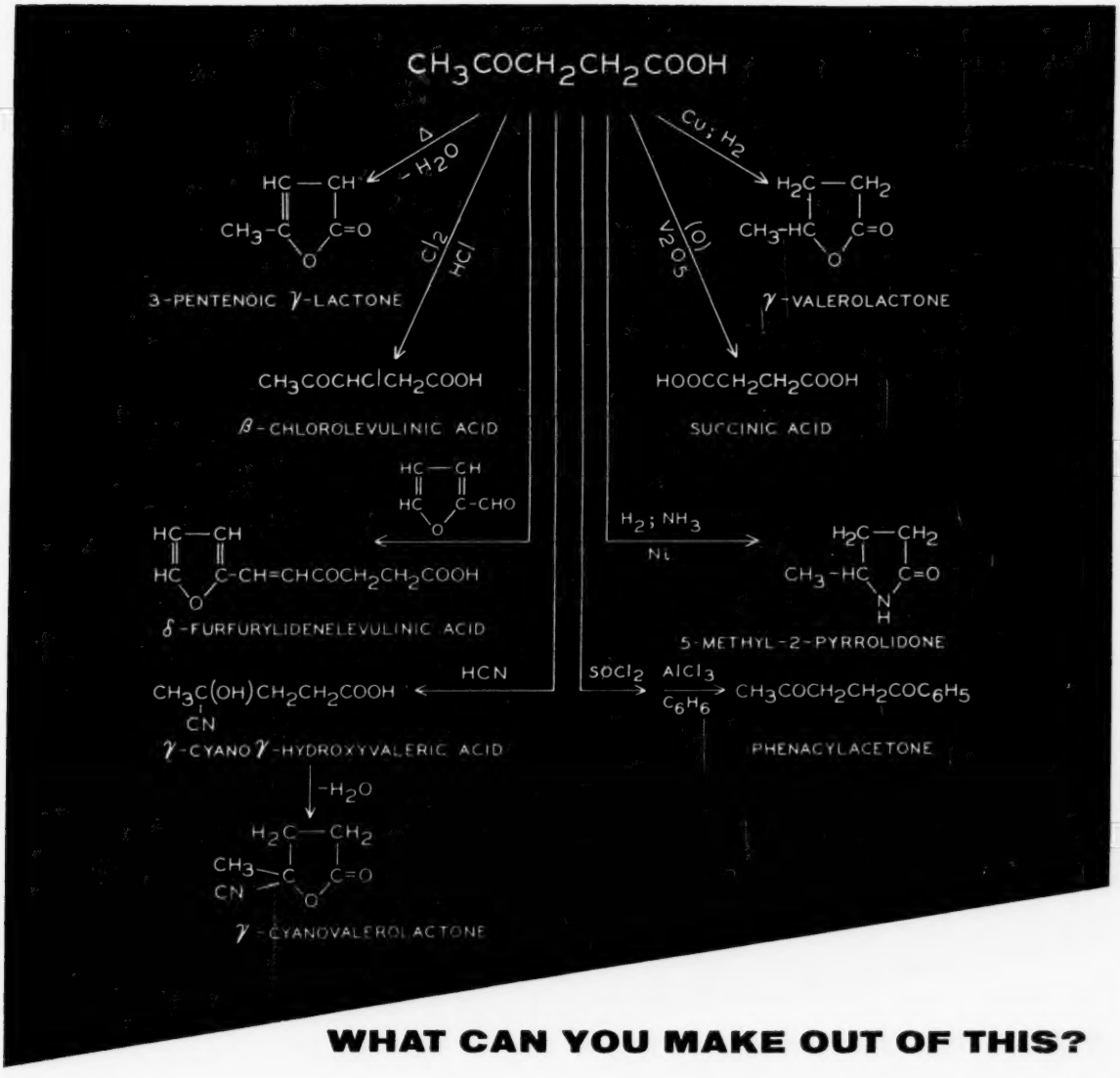
Dollar sales volume, at an estimated 54% in 1958, already exceeds that of the tire segment.

▶ **What's New?**—Generating the bulk of development work in rubber-chemicals:

- Lighter-colored, nonstaining, nondiscoloring rubbers, unknown several years ago, now account for 30-40% of synthetic production. They require nonstaining antioxidants, extending oils and even reinforcing agents to substitute for carbon black.
- Stepped-up production cycles (which mean higher heats for shorter periods) plus increased use of fine furnace black (more scorchy than older channel black) keep calling for more and better delayed-action accelerators.
- Realization of need for specific antiozonant protection, born in the early 1950s, is adding a whole new chapter to the antioxidant story, has been a major factor in bringing antioxidant business up 75% in 1946-56.

▶ **Lighter Colors**—For researchers into nonstaining antioxidants, the goal—as yet unattained—is a product as effective as the stainers in extending storage or service life of the rubber while causing no discoloration or color change. A number of relatively nonstaining antioxidants have come on the market

SOME REACTIONS OF **QO LEVULINIC ACID**



WHAT CAN YOU MAKE OUT OF THIS?

This is QO Levulinic Acid, a particularly interesting chemical with polyfunctional characteristics. For example—it acts both as a carboxylic acid and as a ketone. The hydrogen atoms have various degrees of activity. Reactions are possible on the beta or delta carbon and in some instances on the alpha carbon. It cyclizes to heterocyclic forms.

It can be well worth your while to look into QO Levulinic Acid. Write for Bulletin 301 on QO Levulinic Acid and a sample.

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Rubber Chemicals...

☛ ...Many Kinds...

Year	Types	Items
1930	12	203
1940	14	246
1958	28	1,274

☛ ...Many Pounds

Chemicals	Million Lb.
Emulsifiers	135
Catalysts	4
Modifiers	10
Shortstops	6
Stabilizers	18
Activators	18
Sulfuric acid	16
Salt	285
Alum	6
Soda ash	2
Plasticizers & extenders	525
Sulfur	83
Accelerators	27
Antioxidants	23
Zinc oxide	153
Fatty acids	70
Silicas	9
Clays	450
Carbon black	1,210
Nylon	60
Rayon	370
Fillers & pigments	123
Total	**3,603**

in the past few years. Virtually all are hindered phenols whereas the staining types are aromatic amines. The least staining of the aromatic amines are the heptyl, octyl, or nonyl diphenyl amines.

On the other hand, amines are generally better as antioxidants than phenols. Some of the latter, however, approach amines.

Related to the drive for lighter colors is Shell Oil's new nonstaining, light-colored extending oil, Dutrex 33. Oil-extended rubbers, light-colored and otherwise, are increasing. Oil extenders cost 4-5¢/lb. vs. about 28¢/lb. for rubber hydrocarbon stock. They do not adversely affect product properties for many applications, sometimes improve them—they're said to help tread wear. Their use has risen steadily since 1952, and in 1956 accounted for almost 35% of total dry rubber production.

Shell's new oil is a napthenic compound claiming all advantages which aromatic oils conventionally have over napthenics, without taking on aromatics' drawbacks. That is, it has greater compatibility, blends faster, adds strength to the finished product, but does not discolor readily.

Not just the sidewall, but the whole, of automobile tires may go to light, bright colors. Columbia-Southern reports 45,000-mile tread life in test tires reinforced with silica rather than carbon black.

▶ **Faster Rubber Processing**—Rapid production methods and increasing use of reinforcing furnace blacks in tire compounds demand accelerators with more delayed action in order to avoid problems involved with scorching or premature vulcanization.

Furnace blacks have a basic pH and activate the accelerator curing system; channel blacks, with an acidic pH, retard it. In 1957 furnace black represented about 82% of the 1.3 billion lb. of carbon black sold to the rubber industry; as late as 1949 channel black still held a slight edge. (A big reason for present rubber industry preference: The finer furnace blacks impart better abrasion resistance.)

These new process conditions have been responsible for the introduction of several new delayed-action accelerators. The most successful have been benzothiazolesulfenamide-type accelerators (eg., Monsanto's Santocure, N-cyclohexylbenzothiazone-2-sulfenamide; American Cyanamide's NOBS Special, N-oxydiethylenebenzothiazone-2-sulfenamide). More are expected from that quarter.

▶ **Antiozonants**—By 1950 ozone degradation of rubber had become serious enough to prompt introduction of the first specific antiozonant, Monsanto's Santoflex AW; and antiozonant development is still spurring some of the most active research in the rubber-chemicals field.

Ozone failures vary from locality to locality inasmuch as ozone concentration probably depends on a combination of things: geography, industry concentration and type, number of motor vehicles giving off exhaust in a given area. Also, during and since World War II the expensive practice of wrapping new tires, mummy-like, in paper was stopped, affording more exposure to ozone attack.

Available antiozonants are still few. Monsanto, Universal Oil Products, Burke Research, Bayer and Eastman Kodak are the factors in the market. Products, in general, are derivatives of *p*-phenylene diamine. Difficulty in developing new compounds has been in combining effective performance with toxicity low enough to avoid difficulties in industrial handling.

▶ **Butyl Push**—The battle with ozone has also been fought via ozone-resistant rubbers; nearly saturated or saturated compounds such as butyl rubber; Hypalon; the Thiokols; and silicone rubbers.

A strong push in the last few years to widen butyl's horizons, even to use in all-butyl passenger-car and truck tires, has required development of new rubber-processing chemicals.

Some credit for butyl's new ability to resist heat buildup in both passenger-car and truck-tire use goes to a chemical additive, Monsanto's Elastopar.

U. S. Rubber's new HTB butyl, which gives mechanical goods a sustained heat resistance of from 300-400 F., is based on a new nonsulfur cure.

▶ **Nonsulfur Cures**—In the field of nonsulfur cures, Hercules Powder has developed a method of rubber vulcanization without sulfur or sulfur-containing compound. Key is dicumyl peroxide, called Di-Cup, now available in quantity through Hercules' cumene-oxidation process.

And this is another development that should point the way to new colors not now practical in rubber goods. Di-Cup vulcanizes rubber by carbon-to-carbon cross-linking, produces basic rubber compounds with very light colors, with mechanical properties said to be comparable to sulfur-vulcanized rubbers, and with markedly superior ageing resistance.

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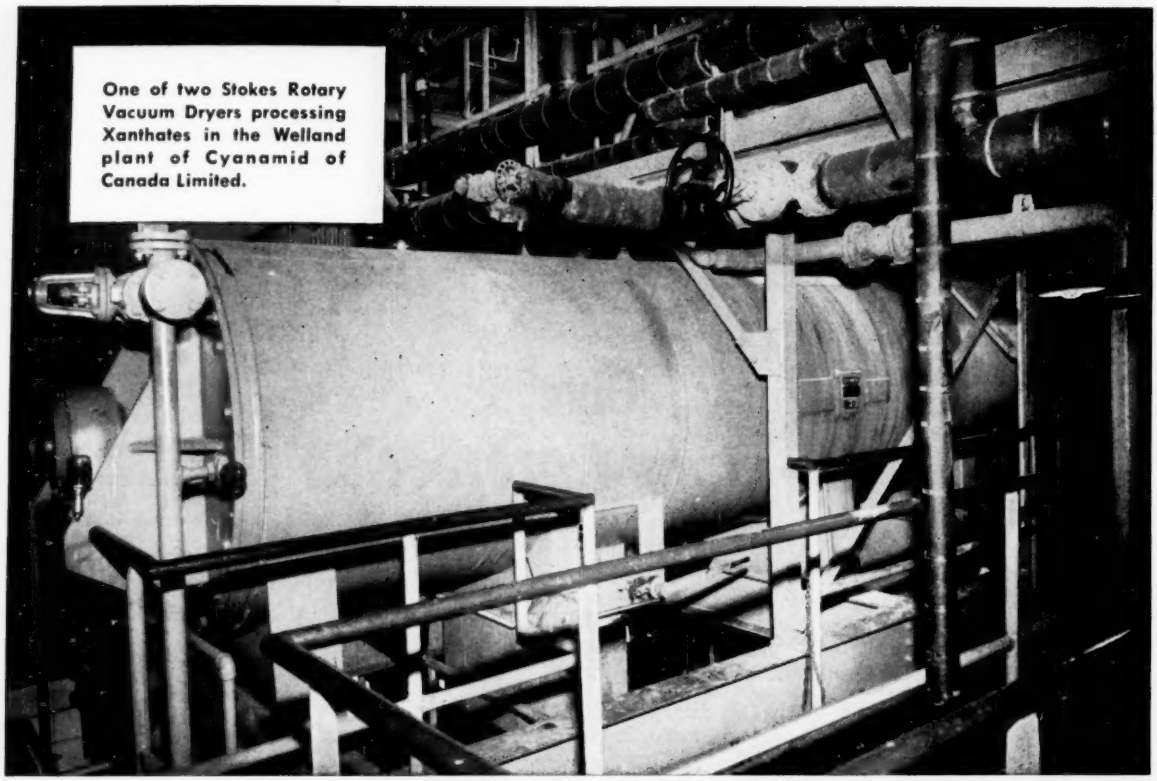

One of two Stokes Rotary Vacuum Dryers processing Xanthates in the Welland plant of Cyanamid of Canada Limited.

Stokes Rotary Vacuum Dryers process Xanthates for Cyanamid of Canada Limited

The Welland plant of Cyanamid of Canada Limited, near Niagara Falls, Ont., is the only Canadian producer of Xanthates . . . a series of materials used in mining and mineral industries as flotation reagents. Stokes Rotary Vacuum Dryers play an important part in the production of these heat and air sensitive materials.

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Users say Allis-Chalmers lift trucks are the most productive and efficient they ever used. Their heavy-duty industrial engines deliver more usable power, do extra work every hour, stay on the job longer.

Allis-Chalmers GS (gasoline safety) lift trucks are available in capacities from 3,000 lb to 10,000 lb. Diesel, DS-approved safety trucks also are available in several sizes. Ask your dealer to show you how these trucks can contribute to the economy of your operation, or write for literature.

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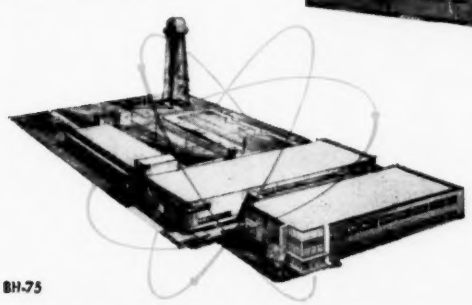

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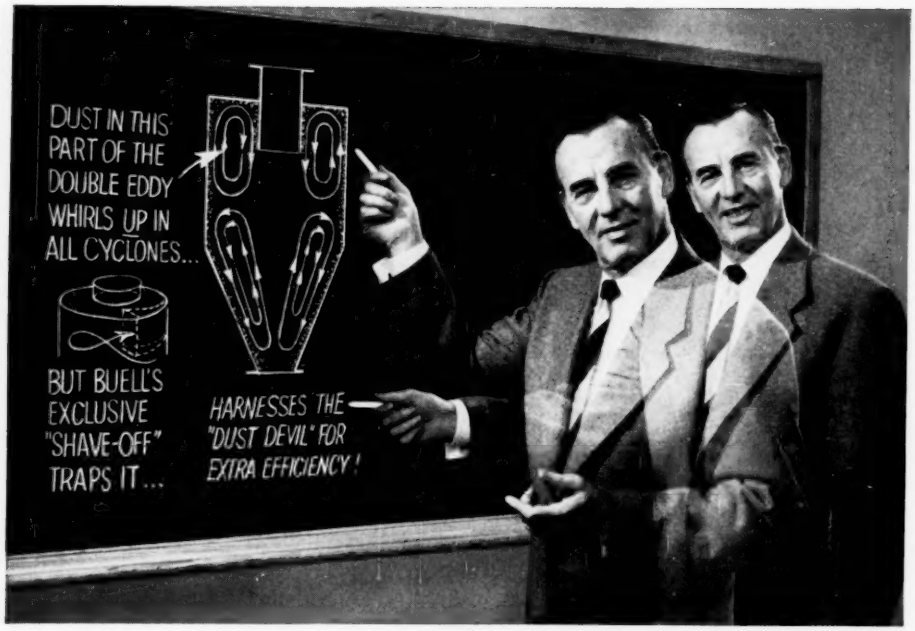
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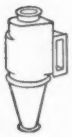
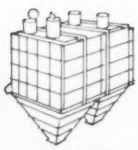
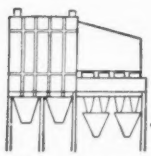
BUT BUELL'S EXCLUSIVE "SHAVE-OFF" TRAPS IT...
HARNESSES THE "DUST DEVIL" FOR EXTRA EFFICIENCY!



BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS



PRECIPITATOR-CYCLONE COMBINATIONS

Only Buell Cyclones have the "Shave-off" that removes the fines carried in the double-eddy currents, minimizes reentrainment, assures measurably higher dust collection efficiency! Other exclusive extra-efficiency features include *large-diameter* design that eliminates bridging and clogging, proper proportioning for maximum dust separation from the gas stream, extra-heavy-gauge, wear-resistant construction, Buell-designed manifolding that minimizes draft loss, minimizes scouring and eddying. For more information send for a copy of the booklet, "The Exclusive Buell Cyclone." Dept. 12-F, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

High-Strength Bonded Clad Material Described in New CB&I Bulletin

Hortonclad is a corrosion-resistant composite metal having an integral and continuous bond of exceptionally high strength produced by a special high-vacuum bonding process. Available only in CB&I-fabricated tanks, pressure vessels and other clad structures, Hortonclad provides uniform thickness because cladding and backing plate are both in their final thickness prior to bonding.

The Hortonclad process employs silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other metals and alloys.

Write our nearest office for a copy of the CB&I bulletin which describes these benefits of HORTONCLAD:

- UNIFORM THICKNESS
- HIGH STRENGTH BOND
- CLEAN, CONTAMINANT-FREE SURFACE
- ADAPTABILITY TO ANY SIZE OR SHAPE

Two crude columns (left) and vacuum column (right) were partially clad using Monel Hortonclad and stainless steel. Crude columns are 174-ft. high. Vacuum column is 28-ft. in dia. at widest point and 125-ft. high.

P71-C

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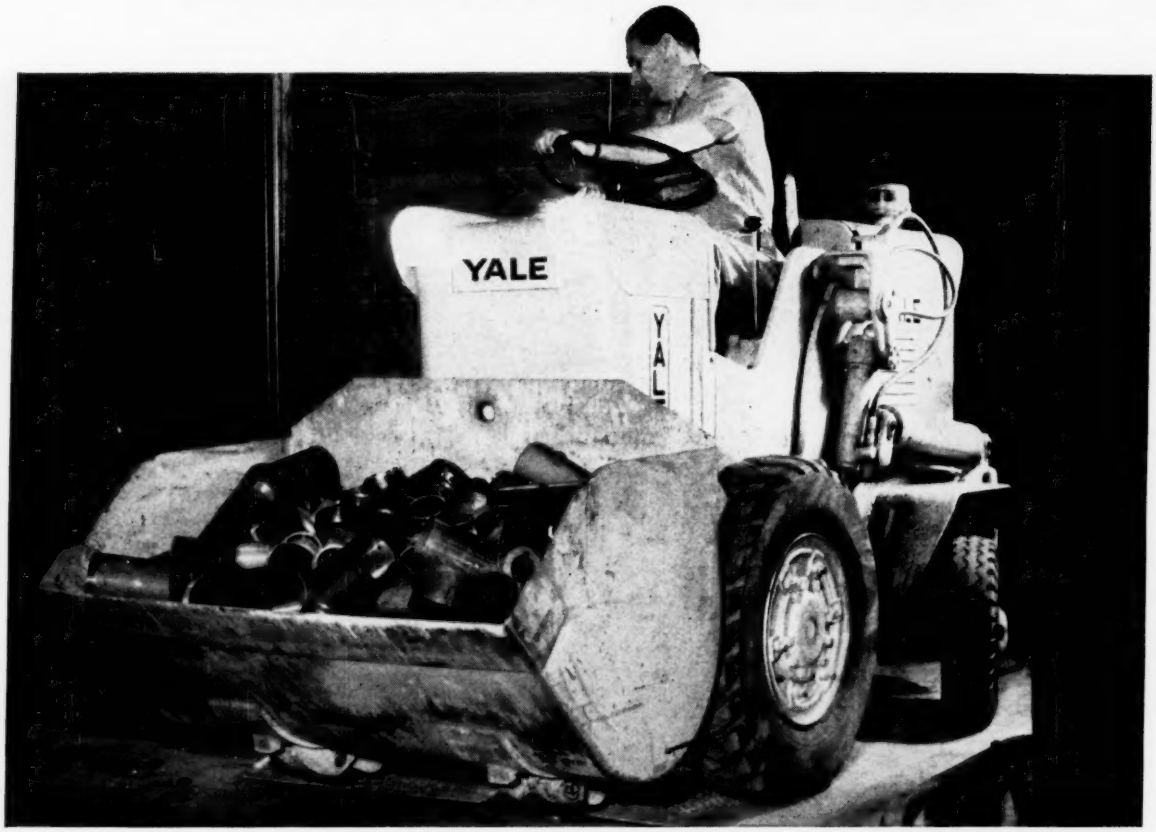
CB&I

NEW YALE INDUSTRIAL TRACTOR SHOVEL



Carries more tonnage every hour

—field tests prove it!

Actual field tests prove the amazing work-capacity of the new Yale Industrial Tractor Shovel. Extra tonnage—extra work—extra duty cycles! Operating acceleration speed is 8 mph in 3.5 seconds. And Yale's exclusive fully automatic Torque Transmission produces quicker, smoother starting, more power under load conditions.

Loader-linkage advantages are unique. Exclusive 45° ground-level tipback provides top loading action, minimum spillage in grade-level position. Exclusive 6′ dumping clearance (highest on any model of similar wheelbase) automatically returns bucket from full dump position to dig position.

Let your operator work with it. He'll like the roomy, clear cockpit—the finger-tip controls—the ease of handling—the fact that there are no gears to shift. He'll especially like Yale's exclusive Safety-Curve Arms —that never rise above the side frame to cause injury. For a demonstration in your plant or further data write The Yale & Towne Manufacturing Co., Philadelphia, Pa., Dept. A-446.

COMPARE THESE YALE FEATURES:

- Exclusive Yale Torque Transmission (fully automatic)
- Exclusive 45° ground-level bucket tipback
- Exclusive 6′ dumping clearance
- Exclusive Safety-Curve Arms
- Exclusive acceleration speed to 8 mph. in 3.5 sec.
- Exclusive sealed brakes
- Exclusive forward and rear operating lights
- 2500 lbs. carrying capacity
- Short wheelbase for minimum turning radius
- Gasoline or LP-Gas powered

YALE* *REG. U. S. PAT. OFF.

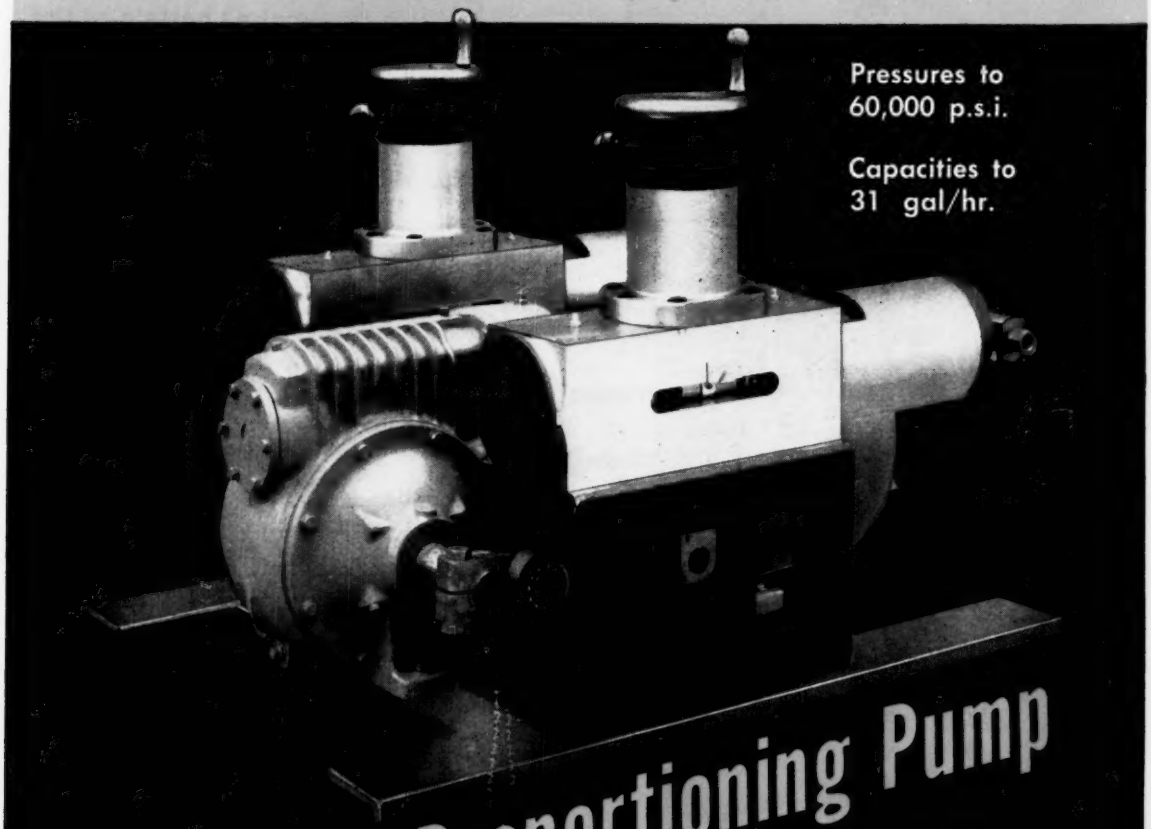
YALE & TOWNE

INDUSTRIAL LIFT TRUCKS & TRACTOR SHOVELS • HOISTS

GASOLINE, ELECTRIC, DIESEL & LP-GAS INDUSTRIAL LIFT TRUCKS • WORKSAVERS
WAREHOUSERS • HAND TRUCKS • INDUSTRIAL TRACTOR SHOVELS • HAND AND ELECTRIC HOISTS

YALE MATERIALS HANDLING DIVISION. THE YALE & TOWNE MANUFACTURING CO. MANUFACTURING PLANTS: PHILADELPHIA, PA.; SAN LEANDRO, CALIF.; FORREST CITY, ARK.

24-hour-a-day service under the most severe chemical plant conditions



Pressures to 60,000 p.s.i.

Capacities to 31 gal/hr.

Chemical Proportioning Pump

A pump that provides trouble-free service for chemical plants on a 24-hour-a-day schedule. The pump will operate at rated pressures for as long as a year and a half without a major overhaul.

- Piston stroke manually-variable from 0 to 100% while pump is under full load.
- Stroke-varying mechanism does not move while pump is in operation, permitting very accurate volumetric settings while operating.
- Displaces entire contents of the cylinder at each stroke of piston, irrespective of stroke adjustment. Length of stroke is shown on an indicating scale.

- Both fixed and variable stroke models available.
- Piston and cylinder assemblies are interchangeable in housing, making it possible to change capacities and pressure ratings.
- Simplex and duplex models available as standard. Triplex and quadruplex models can be supplied on special order.

Complete information in
Bulletin 4065-C
furnished upon request

AMINCO

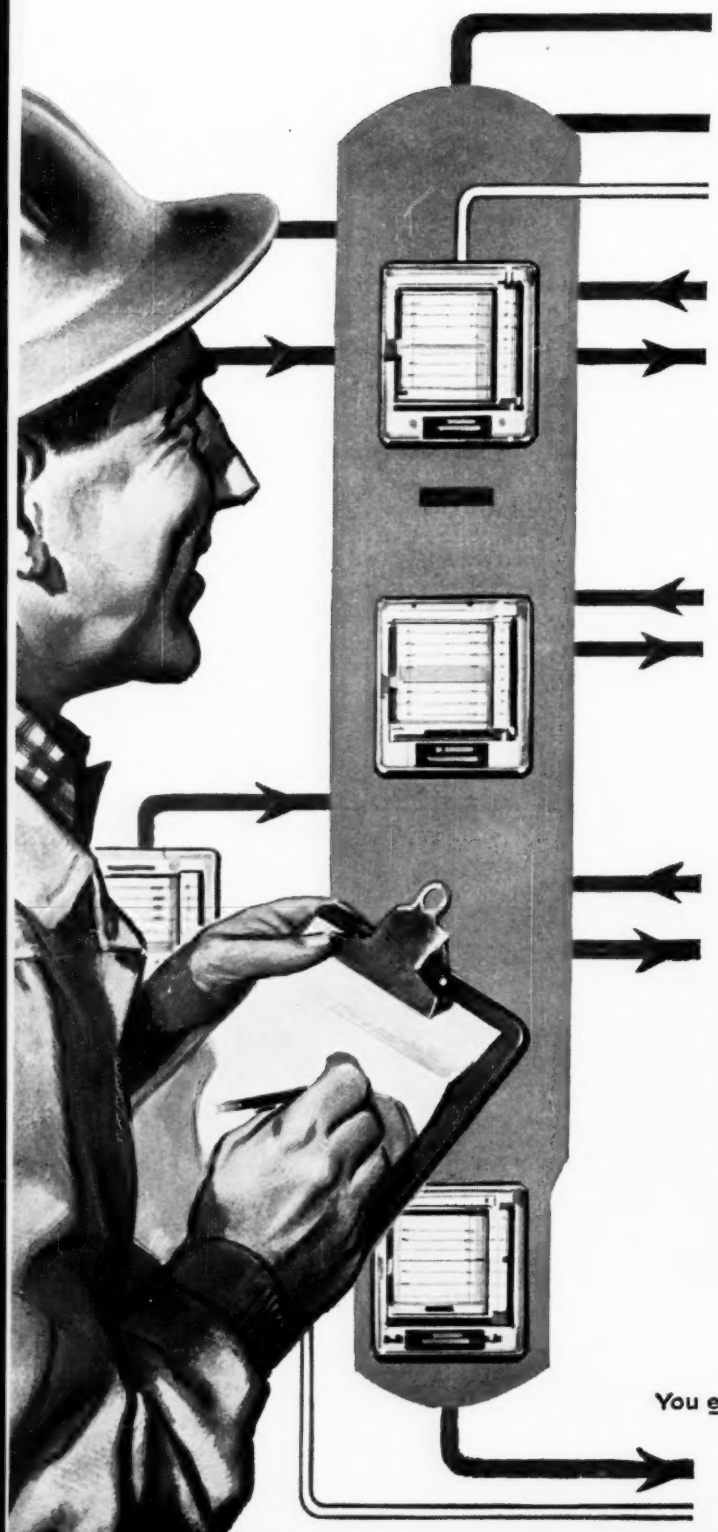
AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Maryland

In Metropolitan Washington, D. C.

Nothing gets by

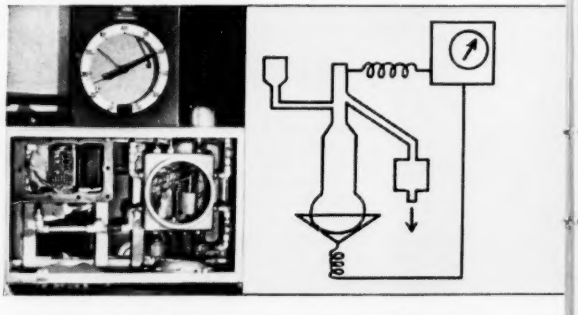
Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.



Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically*.

One such instrument automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which gasoline and diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of (1) the fuels you burn for heat or use to power your diesel engines and (2) the gasoline for your truck fleets. It also means that power- and heat-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

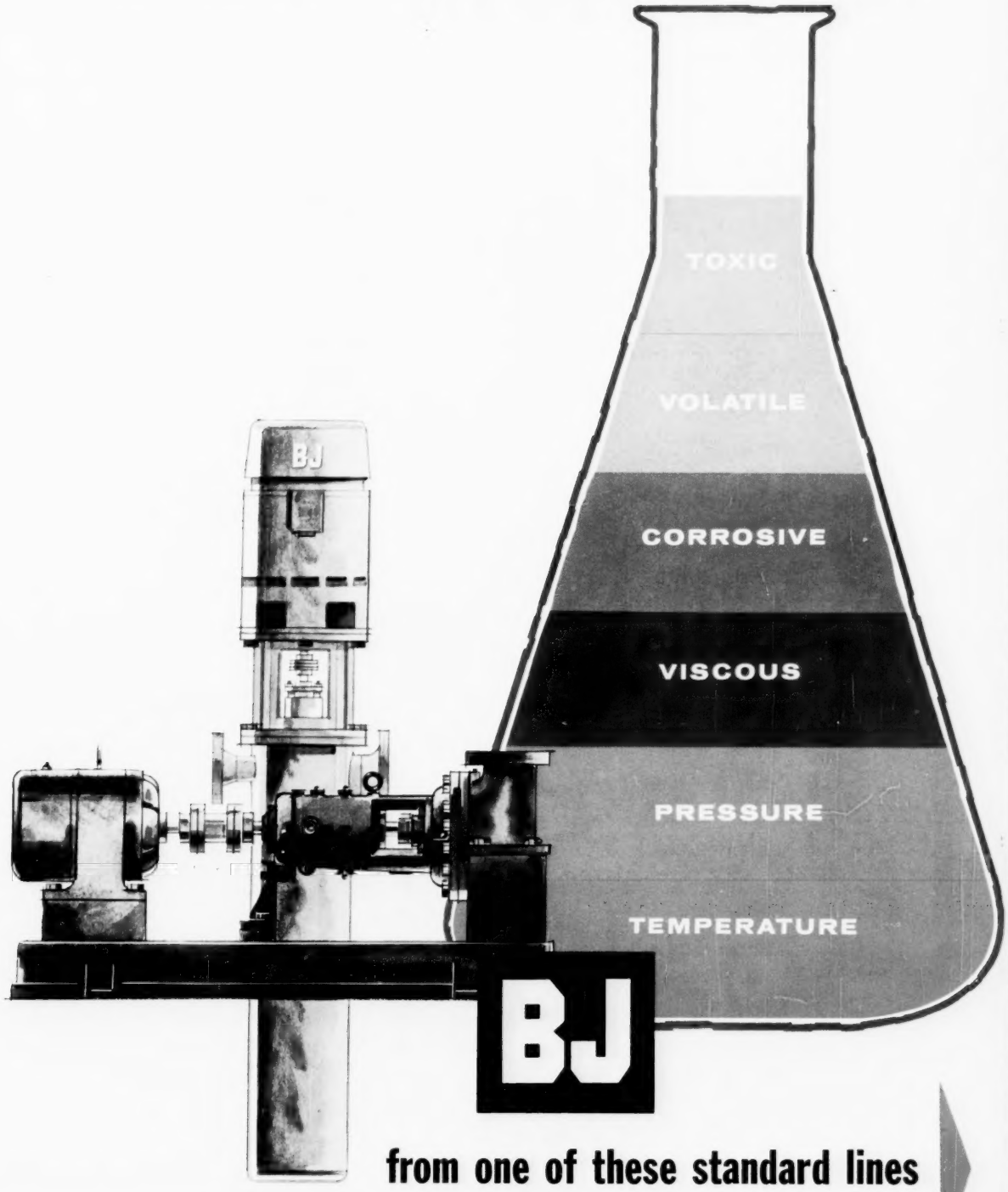


Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

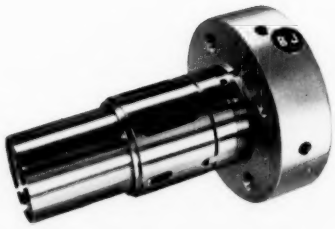
Name your toughest pumping job...

BJ CAN MATCH IT WITH A RELIABLE PUMP!



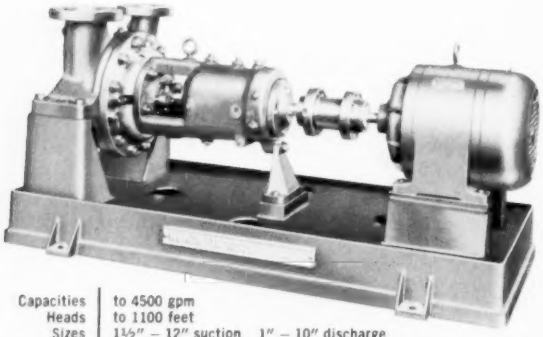
from one of these standard lines

BJ Standard Pumps—engineered to your process handling requirements!



WHILE RELIABILITY IS the most important single feature demanded in a process pump, operating conditions are often the most rugged. Extremes of high or low temperature . . . corrosive, toxic and volatile fluids are encountered.

As part of Byron Jackson's complete line of centrifugal pumps, the models shown here were designed especially for different process pumping conditions. *All are available with the BJ Mechanical Seal for dependable, top performance.*



Capacities	to 4500 gpm
Heads	to 1100 feet
Sizes	1½" – 12" suction 1" – 10" discharge
Temperatures	– 320°F to 800°F

SM PROCESS PUMPS

Developed for handling fluids over a wide range of pressures and temperatures. Basically a single stage, single suction horizontal pump, the SM Series is designed for continuous operation with easy dismantling for inspection or service. Ideal for pumping hot or cold liquids near vapor pressure . . . for corrosive or non-corrosive service. Two stage, as well as double suction models available . . . also models with integrally-built BJ Mechanical Seals.

BJ MECHANICAL SEAL

Replaces standard stuffingbox packing. Eliminates excessive leakage, frequent repacking and shaft sleeve replacement. Materials and construction combinations for almost any corrosion, pressure, temperature or liquid handling need. Since BJ manufactures both mechanical seals and pumps, you are assured of a completely reliable process pump from a single, responsible source.

VMT PUMPS

Mounted in a self-contained suction sump, ideal for use where net positive suction head is limited. Saves floor space. Single or multi-stage to meet the particular job. Sump barrel length determined by NPSH requirement. For corrosive or non-corrosive service.

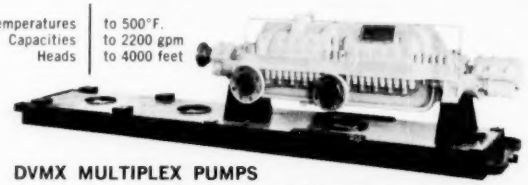
Temperatures	320°F to 550°F
Capacities	to 9000 gpm
Heads	to 2000 feet

VERTICAL CIRCULATING PUMPS

High efficiency with medium-to-high capacities. Single or multi-stage, turbine type units have simplified piping and installation . . . use little floor space.

Pump sizes	16" to 57"
Capacities	to 45,000 gpm
Total head	500 feet

Temperatures	to 500°F.
Capacities	to 2200 gpm
Heads	to 4000 feet



DVMX MULTIPLEX PUMPS

Compact design with double row bolting prevents interstage leakage or bowing at parting flanges – even at 4000 psi hydraulic pressures! Symmetrical design allows safe operation to 500°F . . . metallurgy and construction permit speeds to 7000 rpm. Easily adaptable for interstage take off at intermediate pressures.

BJ OFFERS A COMPLETE LINE of pumps to answer almost any need. Send us your job description for a specific recommendation.

BJ SINCE 1872

Byron Jackson Pumps, Inc.

A Subsidiary of Borg-Warner Corporation

P.O. Box 2017, Terminal Annex • Los Angeles 54, California

PRINTED IN U.S.A.

CONTOUR TRENTWELD TUBING is available in a wide range of grades including Hastelloy,* Zirconium, Zircaloy, Titanium, 19-9-DL — and in 10 basic tubing classifications (pressure, mechanical, aircraft, heat resistant, ornamental, sanitary, beverage, large diameter, shaping and formed tubing).

*Trademark of Haynes Stellite Co

get high strength and uniformity with **TRENTWELD** stainless and high alloy pipe and tubing (*sizes range from 1/8" to 40" O.D.*)

As Trent makes them, today's welded pipe and tubing are as strong as – and even more uniform than – pipe and tubing made by any other method of manufacture. That's because (1) an exclusive welding process (Contour Trentweld®) virtually eliminates any bead or undercut, and (2) cold working and annealing after welding make the weld equal in strength and corrosion resistance to the parent metal.

Furthermore, Trent checks the quality of its pipe and tubing with a series of strict tests. All strip going into the welder is checked for width and tolerance. Samples of each lot are tensile tested. Periodic tests – flattening, reverse bend, flare and flange, coil and pressure – are conducted. Pipe and tubing for corrosive applications get rigid corrosion tests. And, if necessary, "single-wall" X-ray inspections, exclusive with Trent, can be made on any lot.

Naturally, pipe and tubing made to these standards can't be surpassed for strength, uniformity and service. But get complete details –

Mail coupon for free 48-page Trent tubing handbook — contains complete data on physical, chemical, electrical properties, corrosive data, theoretical weights, hardnesses, etc.

CONTOUR TRENTWELD

TRENT TUBE COMPANY

Subsidiary of Crucible Steel Company of America

General Offices, East Troy, Wisconsin

Gentlemen: Please send me the 48-page Trent Tubing Handbook.

*Name*_____

*Firm*_____

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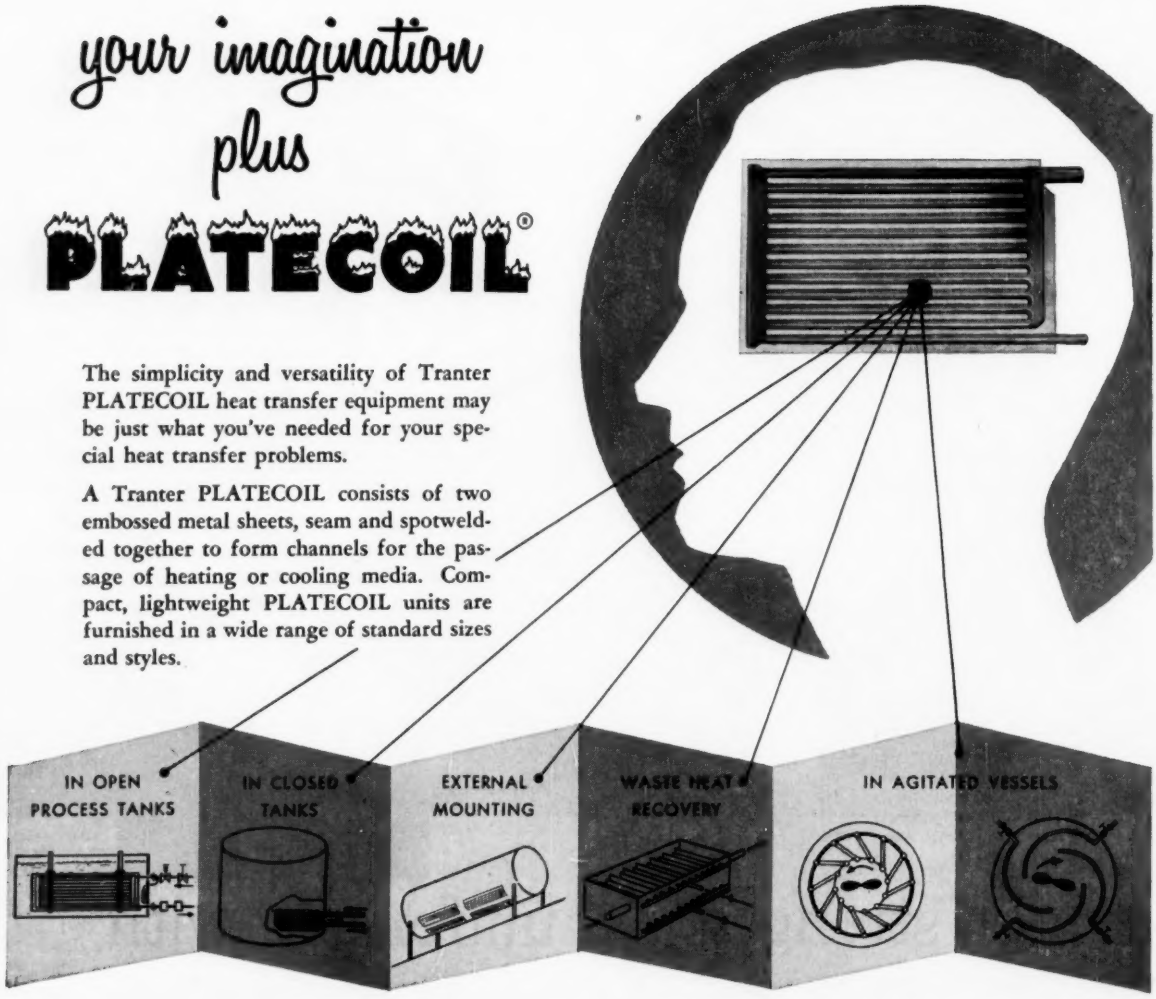
*City*_____ *Zone*____ *State*_____

FORMULA FOR SPECIAL HEAT TRANSFER PROBLEMS

your imagination
plus
PLATECOIL®

The simplicity and versatility of Tranter PLATECOIL heat transfer equipment may be just what you've needed for your special heat transfer problems.

A Tranter PLATECOIL consists of two embossed metal sheets, seam and spotwelded together to form channels for the passage of heating or cooling media. Compact, lightweight PLATECOIL units are furnished in a wide range of standard sizes and styles.

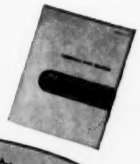


PLATECOIL requires about half the space required by pipe coils and accomplishes heat transfer fully 50% faster than pipe coils.

PLATECOIL units are available in Cold Rolled Steel, Stainless Steel, Carpenter 20, Monel and other corrosion-resistant alloys.

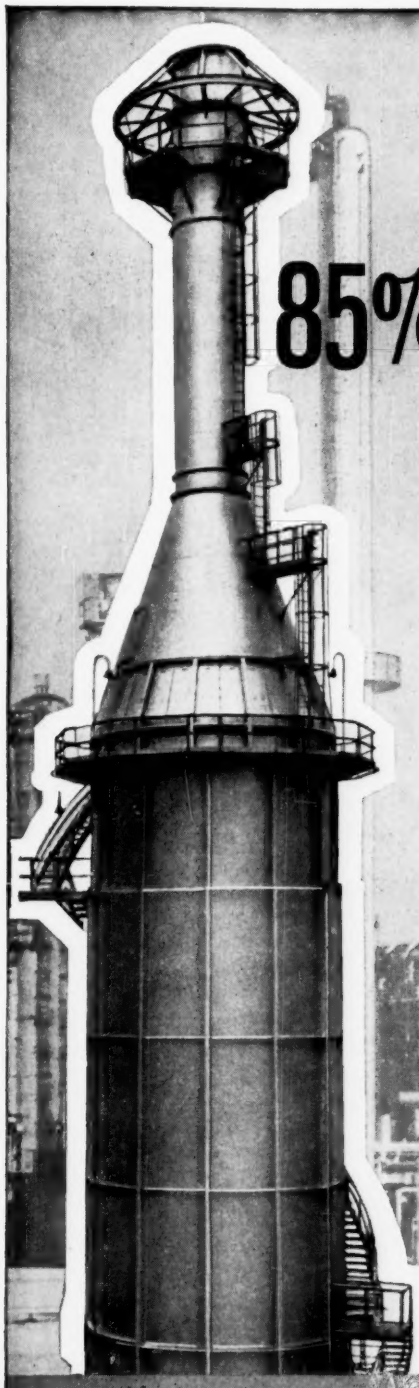
In addition to the many standard styles and sizes, PLATECOIL units can be tailored to fit your exact specifications. Factory fabricated groups, units rolled to specific diameter and units flat on one side are available. PLATECOIL can be galvanized, metallized, electro-polished, polished for food service, prepared for various finishes and furnished with special connections.

SEND FOR FREE TECHNICAL DATA MANUAL P61
FOR COMPLETE ENGINEERING DATA



Tranter Manufacturing Inc.
LANSING 9, MICHIGAN

PLATECOIL® DIVISION



BUTADIENE CAPACITY INCREASED

365,000 Tons/yr in 1957

85% THRU ISOFLOW HEATERS

...and "Isoflows" in five new Butadiene plants are additionally supplying 1,000,000 lbs/hr of superheated steam up to 1400° F

Butadiene capacity is mushrooming to meet the rising demands of synthetic rubber and chemicals. Of the new butadiene plants put into operation during 1957, Petrochem Isoflow Furnaces have been installed in the 5 largest, representing approximately 85% of the total increased capacity in the U.S.

Isoflow Furnaces efficiently perform two important heating functions, depending upon the butadiene process involved:
(A) To heat directly the butane-butene feed stock and steam to a high temperature for dehydrogenation.
(B) To supply highly superheated steam which in turn heats the butane-butene stock for dehydrogenation.

The unique design and operating features which have led to the wide acceptance of Petrochem Isoflow Furnaces include:

- **Uniform Heat Distribution**
- **Maximum Fuel Efficiency**
- **Low Pressure Drop**
- **Low Maintenance**
- **Zero Air Leakage**
- **Minimum Ground Space**
- **Simplicity of Design and Construction**
- **Short Length of Liquid Travel**
- **Series, Multipass, all parallel flow**
- **Excess Draft for High Overload**

For butadiene production, catalytic reforming or any other petroleum, petrochemical or chemical process there's a Petrochem Isoflow Furnace for any duty, temperature and efficiency.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE ... CAPACITY ... DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

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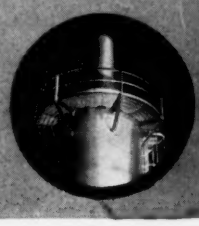
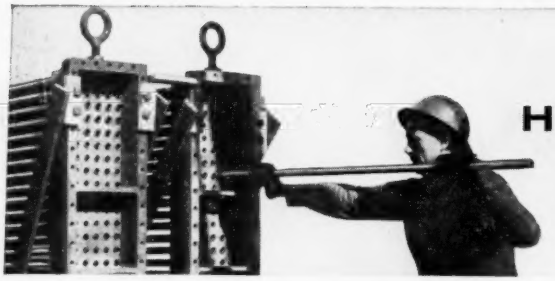


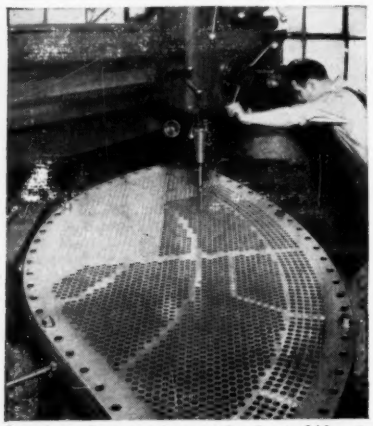


CONDENSER AND HEAT EXCHANGER CLINIC

Edited by Arthur W. Tracy, Metallurgical Engineer
The American Brass Company, Waterbury, Conn.

Selecting alloys for rolled tube sheets and baffles

Tube sheets and baffles are available from The American Brass Company in a wide variety of shapes, sizes and alloys to meet the problems of corrosion, pressure, and temperature encountered in condensers and heat exchangers.



Reaming a large condenser tube sheet of Naval Brass-450.

The following Anaconda alloys are those most widely used for tube sheets and baffle plates.

Leaded Muntz Metal-274 has good strength, stiffness and elasticity. It machines well and is the most commonly used tube-sheet metal. Leaded Muntz Metal hot rolls easily and can be manufactured in very large sizes. Many of the other tube-sheet alloys are superior to Leaded Muntz Metal in corrosion resistance and are used in preference to it for that reason. However, tube sheets are necessarily so thick that a long time elapses before they are affected by corrosion to the extent that their strength or usefulness is impaired.

Naval Brass-450 is an alloy of the same general type as Leaded Muntz Metal but includes approximately 0.75% tin in its composition. The tin content increases the alloy's resistance to corrosion, and makes it preferable to Leaded Muntz Metal, especially at higher-than-normal working temperatures. Hot-working properties of Naval Brass are similar to those of Leaded Muntz Metal.

Arsenical Admiralty-439 is resistant to dezincification corrosion and can be used where its higher resistance to corrosion is required, especially in process equipment.

Ambraloy-917 is available for use where strength and corrosion resistance superior to Naval Brass and Admiralty Metal are desired, as in oil-cooler tube sheets.

Cupro Nickel, 10%-755 and Cupro Nickel, 30%-702 are used extensively with tubes of similar composition in marine condensers and process heat exchangers.

Baffle and Support Plates for use in oil-refinery equipment are most often of Leaded Muntz Metal and Yellow Brass. For more severe applications, Admiralty, Naval Brass, Cupro Nickel, Copper and Everdur® are often employed.

Rolled Plates Superior. Anaconda sheets, plates, and circles are produced by the rolling process. They are commercially flat, accurate in dimensions, and free from the surface imperfections and porosity often prevalent in cast plates.

Standard Sizes. The American Brass Company makes plates for condenser tube sheets of copper and a number of copper alloys in rectangular sizes up to 156 inches in width and weights up to 15,000 pounds for any shape that can be cut from such sheet. The maximum standard limits for circles are 160 inches in diameter and 11,000 pounds in weight. Half circles can be produced up to 13,000 pounds in weight.

Rolled circles of Ambraloy-917, 2" thick, for water-to-water heat exchanger tube sheets requiring superior strength and corrosion resistance. Such circles can be furnished up to 5" thick, offer savings in material cost over comparable circles produced by the forging process.

Special jobs. When specifications call for extremely large plates or special alloys for special applications, The American Brass Company will gladly cooperate in the solution of such problems. For further information on Anaconda Condenser Tubes or Tube Sheets write: The American Brass Company, Waterbury 20, Conn. 5875

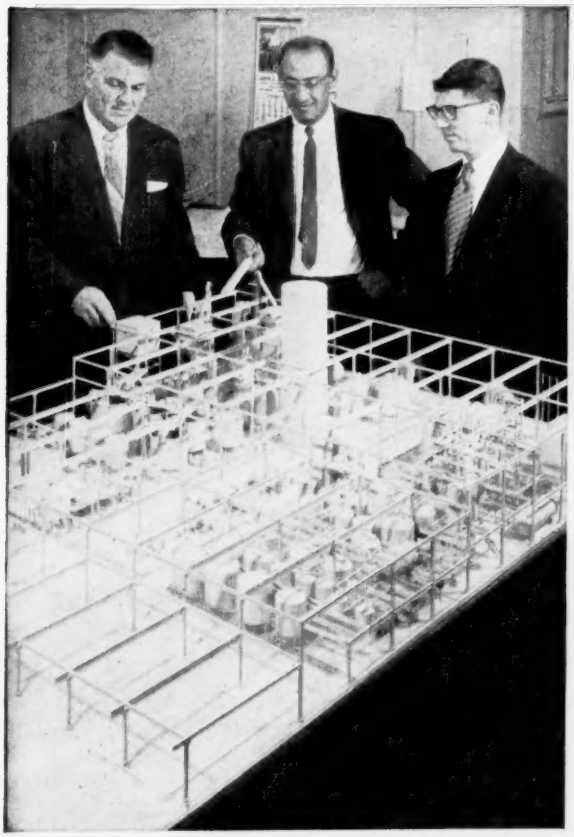
Nominal compositions of Anaconda condenser tube sheet and plate stock

Alloy	Copper %	Zinc %	Tin %	Nickel %	Aluminum %	Lead %	Manganese %	Phosphorus %	Silicon %	Iron %	Arsenic %
Leaded Muntz Metal-274..	60.0	39.40	—	—	—	0.60	—	—	—	—	—
Naval Brass-450.....	60.0	39.25	0.75	—	—	—	—	—	—	—	—
Arsenical Admiralty-439...	71.0	27.96	1.0	—	—	—	—	—	—	—	0.04
Ambraloy-917..... (Aluminum Bronze)	82.0	—	—	5.0	9.50	—	1.0	—	—	2.50	—
Cupro Nickel, 30%-702...	68.9	—	—	30.0	—	—	0.60	—	—	0.50	—
Cupro Nickel, 10%-755...	88.35	—	—	10.0	—	—	0.40	—	—	1.25	—
Phosphorized Copper-103.	99.90+	—	—	—	—	—	—	0.02	—	—	—
Everdur®-1010.....	95.80	—	—	—	—	—	1.10	—	3.10	—	—

*T.M. Reg. U. S. Pat. Off.

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers Made by The American Brass Company



Project planned. Left to right: H. W. Schaffner, production vice president; C. W. Schwenzfeier, Jr., engineering vice president; and N. W. Bass, sales vice president — inspecting an intricate scale model of the new Brush Beryllium plant at Elmore, Ohio.

Project completed! The same executives in front of control panel in new Elmore plant, which contains the latest equipment for producing beryllium. Hydroxide plant has rated capacity of 240,000 lbs. of beryllium a year, but can be readily expanded.

$6 MILLION DREAM COME TRUE!

This is a success story.

It began in 1931 (after ten years of research).

The project: to pioneer the development, manufacture, and application of a new industrial metal — beryllium.

The Brush Beryllium Company, a privately owned enterprise, did it — without fanfare or fuss — overcoming obstacles in the design of facilities to perform newly developed chemical and metallurgical processes.

Today, their fondest dreams have come true in the shape of a new plant that embodies the most advanced equipment yet developed for producing beryllium. This new $4.5 million plant completes a $6 million complex for the production of beryllium and its alloys.

What is beryllium? The only light metal with a high melting point, stiffer than steel and stronger for its weight than any other metal.

Uses? The surface has hardly been touched . . . but beryllium is already used in the atomic energy, electronic, and aircraft industries; in cars, appliances, and business machines, to name a few.

What does this new plant mean? It means that private industry, along with government agencies, now has ready access to sufficient supplies of versatile beryllium to adequately meet their present needs — as well as to meet expected future requirements.

Where does Wyandotte come in? In the words of Brush Beryllium executives: "We met a great challenge. Wyandotte is one of our trusted suppliers, and has aided us immeasurably with fine technical service. Advice on forms of chemicals to buy, how to store and how to handle soda ash and caustic influenced the actual design of the new plant."

If you can use a supplier of Wyandotte's capabilities . . . contact us. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte
CHEMICALS
WYANDOTTE CHEMICALS

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Pacing Progress with Creative Chemistry

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA
CHLORINE • MURIATIC ACID • CALCIUM CARBONATE
CALCIUM CHLORIDE • CHLORINATED SOLVENTS
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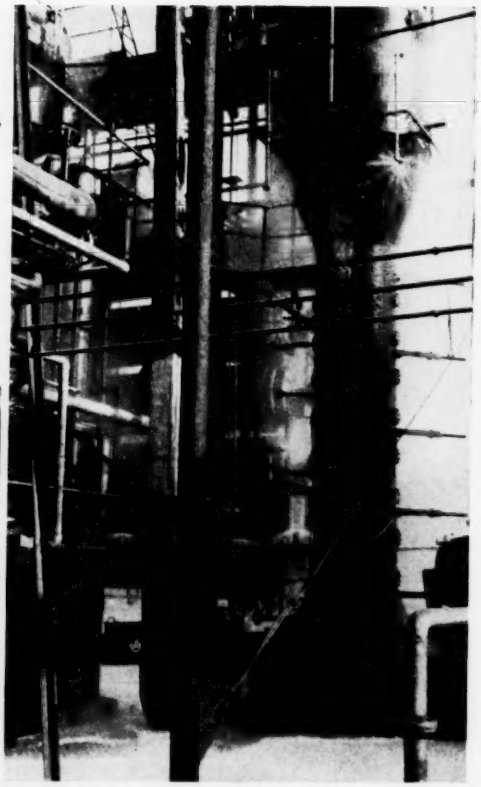
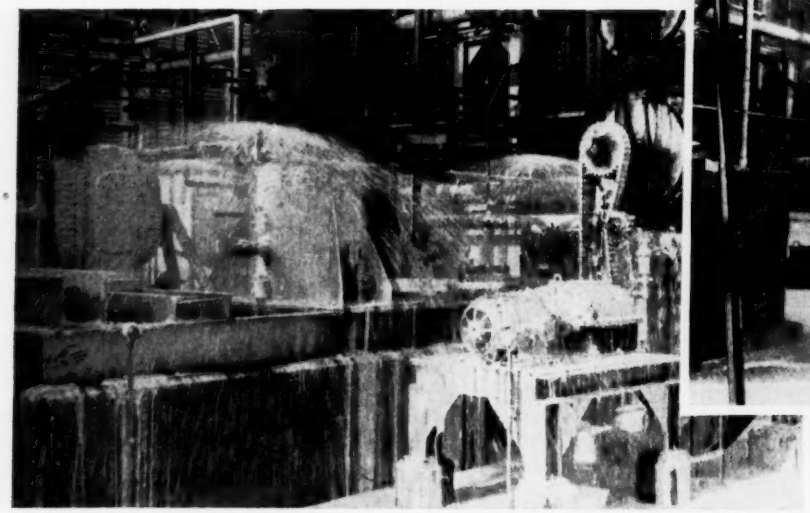
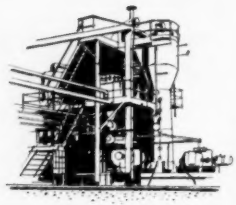
Tough Fire Protection Problem Solved by GRINNELL



▲ Grinnell ProtectoSpray on upper part of unit cools equipment and washes burning oil and solvent into area protected by foam blanket below.



▲ Grinnell ProtectoFoam safeguards the lower section of hexane solvent extraction unit with a blanket of foam, to prevent formation of explosive mixtures.



At Canadian Vegetable Oil Processing Ltd., Hamilton, Ontario, hexane solvent is used in extracting vegetable oil from soybeans. Because of the highly flammable nature of the solvent, Grinnell designed a special system for this unit, consisting of 162 ProtectoSpray nozzles — to drench the superstructure with fine water spray; and 24 ProtectoFoam spray heads — to blanket the diked area with foam. This water-foam combination protects the lives of personnel, as well as shielding equipment from costly damage.

Solving tough fire problems like this with installations engineered to the hazard, tailored to the need, built of highest quality materials is something Grinnell has been doing successfully for more than 85 years. Check the list below for the Grinnell System suited to your requirements. Or, tell us about the fire hazard you face, and let us suggest the proper installation for you. Grinnell Company, Inc., 277 West Exchange Street, Providence, Rhode Island.

Grinnell Fire Protection Systems include:

- Automatic spray sprinklers — wet pipe, dry pipe, Simplex, and deluge systems
- Emulsion and vapor dilution extinguishment with water sprays — Mulsifyre and ProtectoSpray systems
- Cooling, insulation and controlled burning with water sprays — ProtectoSpray systems
- Mechanical foam blanket — ProtectoFoam systems
- Carbon dioxide systems
- Dry chemical systems

Manufacturing, Engineering, and Installation of Fire Protection Systems since 1870

AVAILABLE—A vertical motor with full capacity for thrust loads

Here's a vertical motor that can take maximum hydraulic thrust . . . and handle the weight of rotor, drive shaft and pump parts. It has been designed by Allis-Chalmers to give you a really dependable pump drive.

In addition to high-thrust capacity bearings, this motor offers heavy-duty cast-iron frame, efficient ventilation, in-service lubrication, and outstanding electrical protection in both hollow and solid shaft designs.

Get the facts on "long-run" power from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

NEMA 50th Anniversary MOTOR & GENERATOR SECTION

ALLIS-CHALMERS

A-5691

SPROUT-WALDRON Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

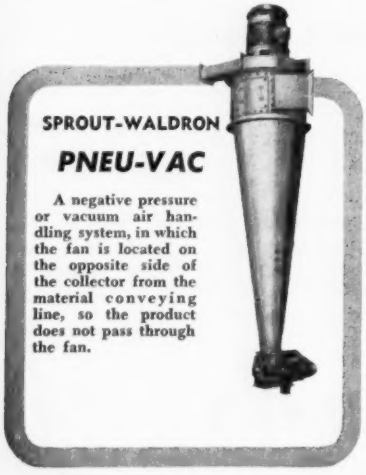
DUST OUT PROFITS IN

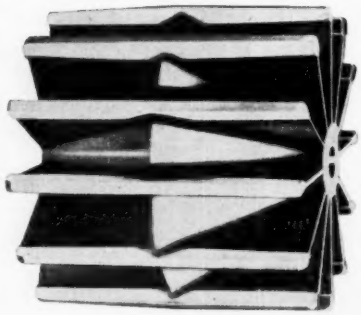
A threatened shutdown because of dust nuisance in the vicinity of his plant proved to be a godsend to a prominent Mid-West manufacturer. It led to his replacement of an inefficient pressure system Collector with an Adaptioneered® negative pressure Pneu-Vac. This brought results he never dreamed of. The dust nuisance was eliminated of course, but that was only the beginning.

His product that was going up in dust was recovered. Maintenance and power costs were reduced.

Because Pneu-Vac operates at negative pressure, dust leaks at joints are impossible, and because passing of material through the fan is avoided, it is applicable to friable materials where particle size reduction is undesirable.

Why not check your own dust problem to see if you are operating an inefficient system, losing valuable products, or suffering high maintenance and power costs. If you are, adaptioneered Pneu-Vac Systems are worth looking into.


SPROUT-WALDRON
PNEU-VAC
A negative pressure or vacuum air handling system, in which the fan is located on the opposite side of the collector from the material conveying line, so the product does not pass through the fan.



Stretch Your Conveyor Dollars With Sprout-Waldron Belt Saver® Pulleys

With maintenance costs at an all time high it is worth taking a careful look at the famous Sprout-Waldron Belt Saver® Pulley which has proven its ability to increase conveyor belt life from 50-400%. These cast iron wing and cone quality pulleys prevent crushing of the material between the face of the pulley and the bottom side of the belt. Sharp lumps and abrasive materials slide away from the pulley adding years of service life to the belt. Whether you are handling crushed stone, sand, asbestos, soda, limestone, cupola slag, salt, fertilizer, concrete, gravel or any other abrasive or difficult to handle material, Sprout-Waldron Belt Saver Pulleys can extend the life of your conveyor belts or bucket elevators and minimize your shutdown and maintenance costs.

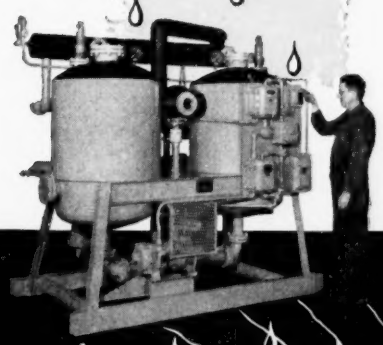
The following chart which compares Sprout-Waldron cast wing Belt Saver Pulleys with fabricated wing pulleys tells its own story. Our unmatched experience is at your disposal.

Characteristics	*Sprout-Waldron Belt Saver Pulleys*	*Fabricated Pulleys*
Construction	Cast Iron	Fabricated
Outside Diameter	Precision ground to insure a smooth surface; crown is exact in pitch and is in dead center	Not ground; distortion during welding makes it difficult to maintain exact pitch of crown or to keep in exact center
Hubs	Both hubs are precision bored	Bored on one end only
Bore Length	Extra long to reduce shaft stress—3½" bore length for 2 7/16" shaft	Short bore—2" bore length for 2 7/16" shaft
Ribs	Fewer ribs needed because belt contact area is greater	Extra ribs required, this means less space for large pieces to discharge. Greater possibility of damage

The above chart was made after careful examination of a widely advertised line of fabricated steel wing pulleys. All the points enumerated may not be true for every competitive pulley, but they are certainly worth your careful review.

CP/104

How to get more for your drying dollar

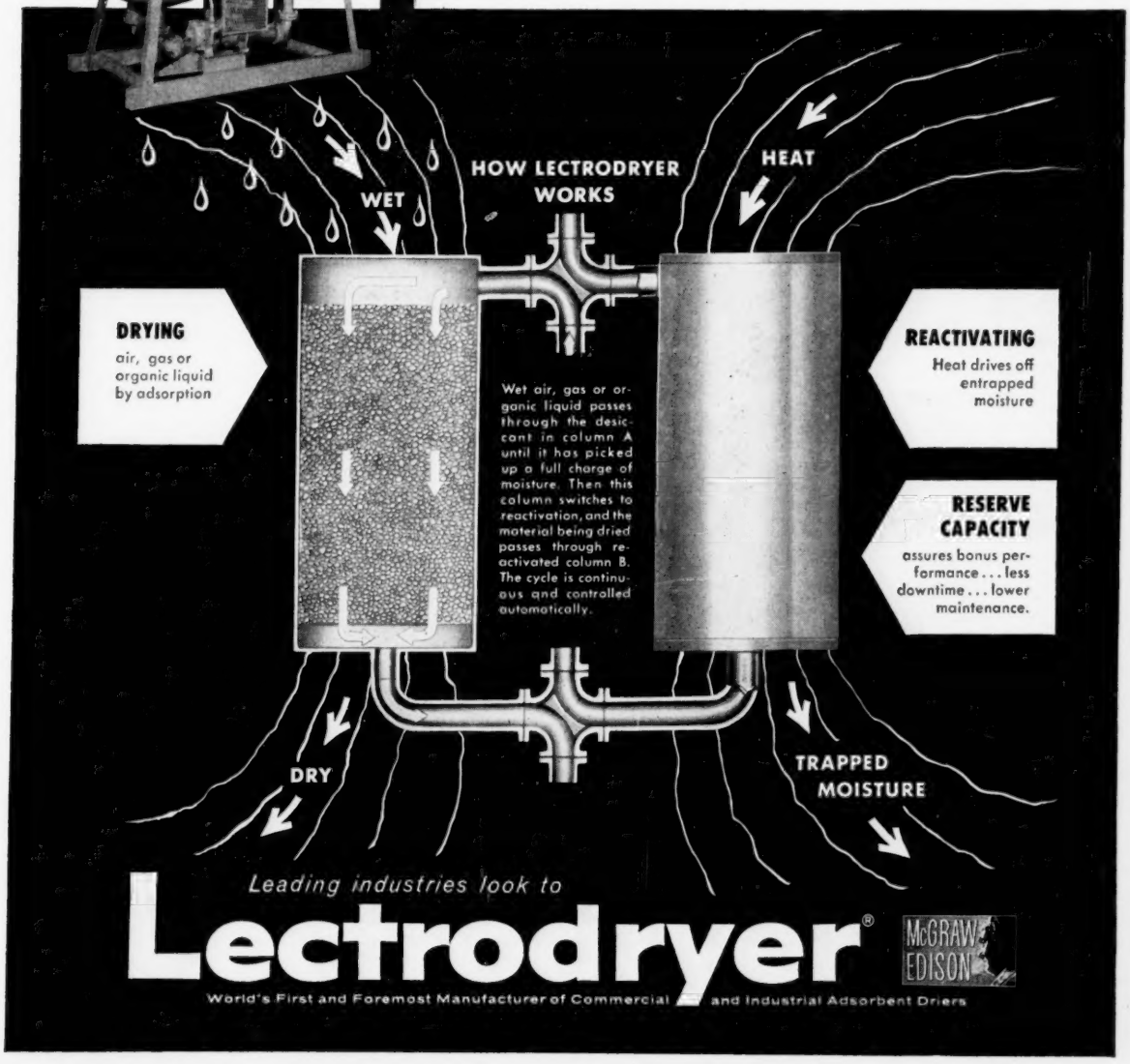


Type BY Lectrodryer for instrument air.

USERS REPORT that Lectrodryer's reserve capacity —in excess of rated output—helps meet normal production growth over the years with no reduction in drying efficiency. The liberal design and rugged construction of Lectrodryers cut downtime and maintenance costs to rock bottom . . . assure sustained, trouble-free, low-cost drying.

Leading industries look to Lectrodryer for better drying because they have found that our high performance standards result in more efficient, more profitable drying operations.

Our engineers will gladly help you solve your drying problems. Write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd Street, Pittsburgh 30, Pennsylvania.


HOW LECTRODRYER WORKS
WET
HEAT
DRYING
air, gas or organic liquid by adsorption
Wet air, gas or organic liquid passes through the desiccant in column A until it has picked up a full charge of moisture. Then this column switches to reactivation, and the material being dried passes through reactivated column B. The cycle is continuous and controlled automatically.
REACTIVATING
Heat drives off entrapped moisture
RESERVE CAPACITY
assures bonus performance... less downtime... lower maintenance.
DRY
TRAPPED MOISTURE
Leading industries look to
Lectrodryer®
McGRAW EDISON
World's First and Foremost Manufacturer of Commercial and Industrial Adsorbent Driers

REASONS WHY ENGINEERS CHOOSE "BUFFALO" PUMPS

Let's think of pumps in terms of hard service on the job — and the reasons why "Buffalo" Pumps deliver maximum efficiency with minimum maintenance for years and years of such service.
Note these rugged construction features of "Buffalo" Full Ball Bearing Single Suction Pumps:

1. Sturdy cast iron bearing stand and casing mounting ring. These components are interchangeable on all size pumps up to and including No. 3. Engineers like this feature, since they often effect economies by standardizing on one line of pumps with varying capacities.

2. Easily-renewable bronze wearing rings protect casing from wear.

3. High efficiency bronze impeller. Enclosed type has liberal openings to handle abrasive solids. Open type, without wearing rings, is optional.

4. Oversize ball bearings running in oil provide rigid support for shaft and impeller.

Add to these the heavy cast iron frame, oversize shaft, extra-deep stuffing box, long-wearing gland with packing furnished — and you have a total of eight superior engineering features built into every "Buffalo" Single Suction Pump.

These plus many more high quality "Buffalo" components provide the sound reasons why engineers look to "Buffalo" Pumps for a long life of efficient, dependable, economical service. For your next heavy-duty pumping job, contact your nearby "Buffalo" Engineering Representative. He will be glad to work with you and help in every way. Or, write us direct for Bulletin 976-E.

"Buffalo" Pumps bring you the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

"Buffalo" Single Suction Pump

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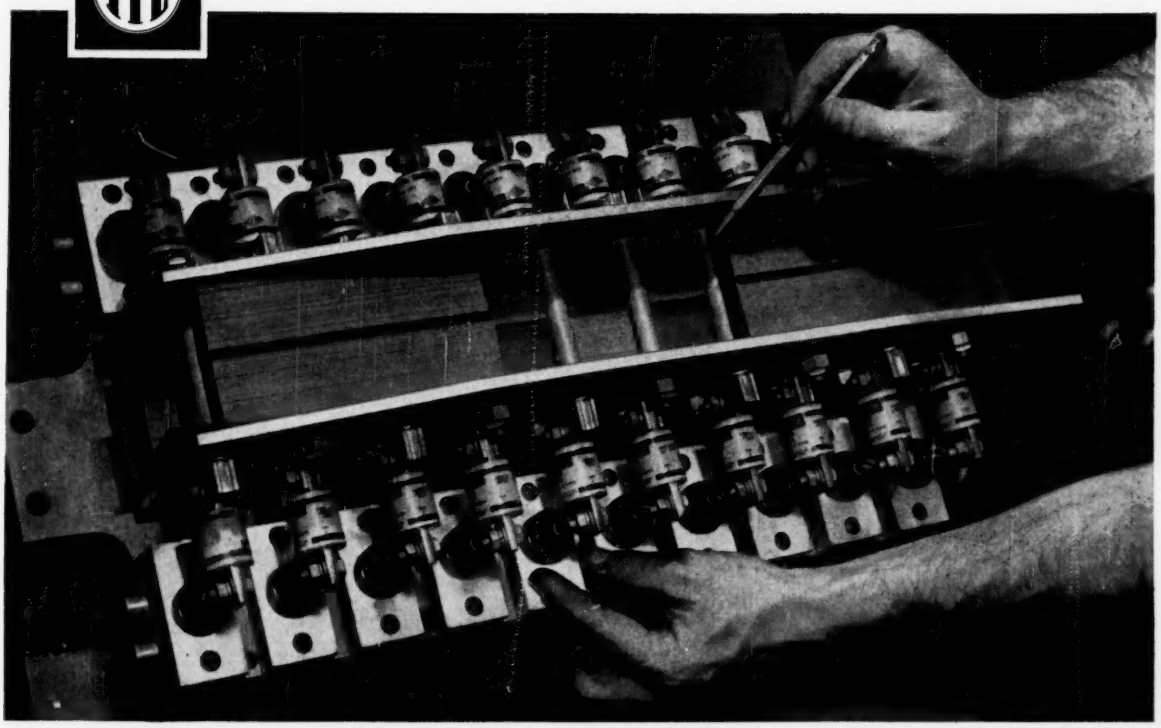
"Buffalo" PUMPS

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

UNITRON SEMI-CONDUCTOR RECTIFIER



Simplicity means dependability. Cutaway model of 20 parallel connected cells reveals how insulated conductors pass through iron laminations.

CURRENT EQUALIZER PROLONGS CELL LIFE AND ASSURES CONTINUITY OF SERVICE

If connected in parallel, semi-conductor rectifying cells will divide the total forward current unequally, due to the difference in forward resistance, causing overloading of the cells with the lowest forward drop.

To make each cell assume its portion of the forward current, the UNITRON uses the current equalizer illustrated above so as to permit parallel operation of random selected cells.

The equalizing action is illustrated by Figs. 1 and 2. None of the parallel connected cells is overloaded at rated current and therefore each cell conducts as if it were fed from a separate power source. This materially extends cell life and results in low cell maintenance cost and minimum downtime.

For your new d-c power source, get the economy and dependability available only in the new I-T-E UNITRON Semi-Conductor Rectifier. Write for information. I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

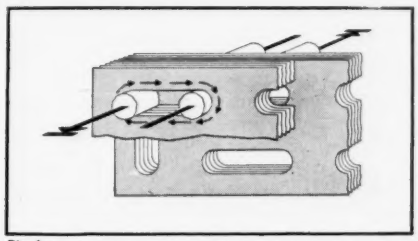


Fig. 1. The two conductors passing through the same window of the iron laminations comprise a 1 to 1 ratio transformer. The currents in the conductors must be equal except for the magnetization current, which does not exceed a maximum of ±10% of cell current.

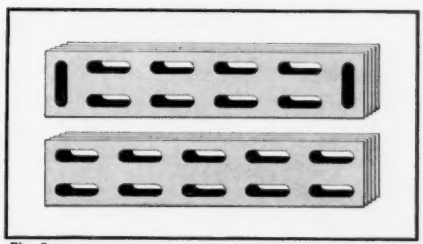
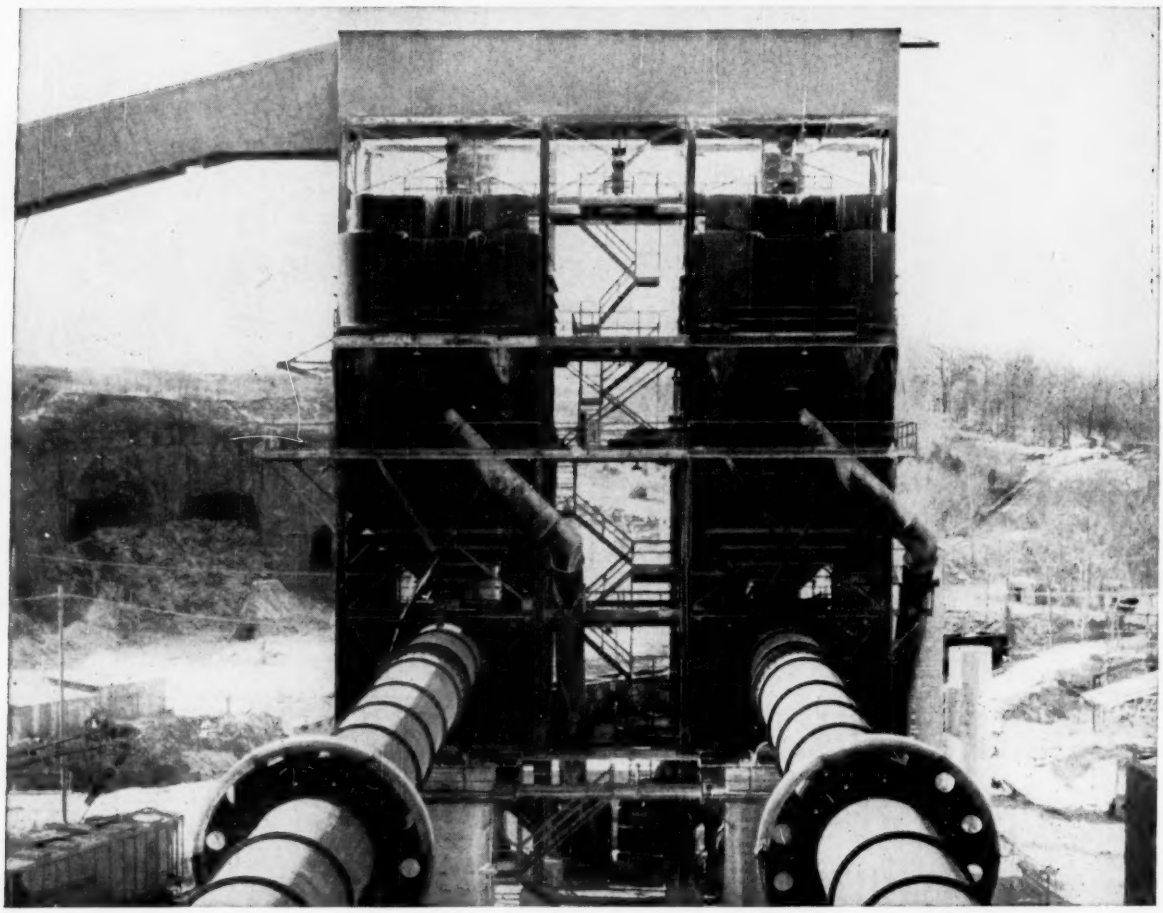


Fig. 2. The iron laminations are divided into two sections, with windows arranged alternately. The windows, when followed progressively in a clockwise direction, form a complete chain in which balance always exists between the current in any one conductor and the currents in the two neighboring conductors.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

KENNEDY LIME PLANTS



▲ KENNEDY Stone Preheaters serve two rotary lime kilns in a new midwest lime plant.

KENNEDY Lime Plants are recognized for their—

- low fuel consumption
- continuous, dependable operation
- top quality product

KENNEDY builds the finest in complete lime plants and lime processing equipment

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SCREENS • CONVEYORS • PULVERIZED COAL FIRING SYSTEMS • HYDRATORS

KENNEDY VAN SAUN
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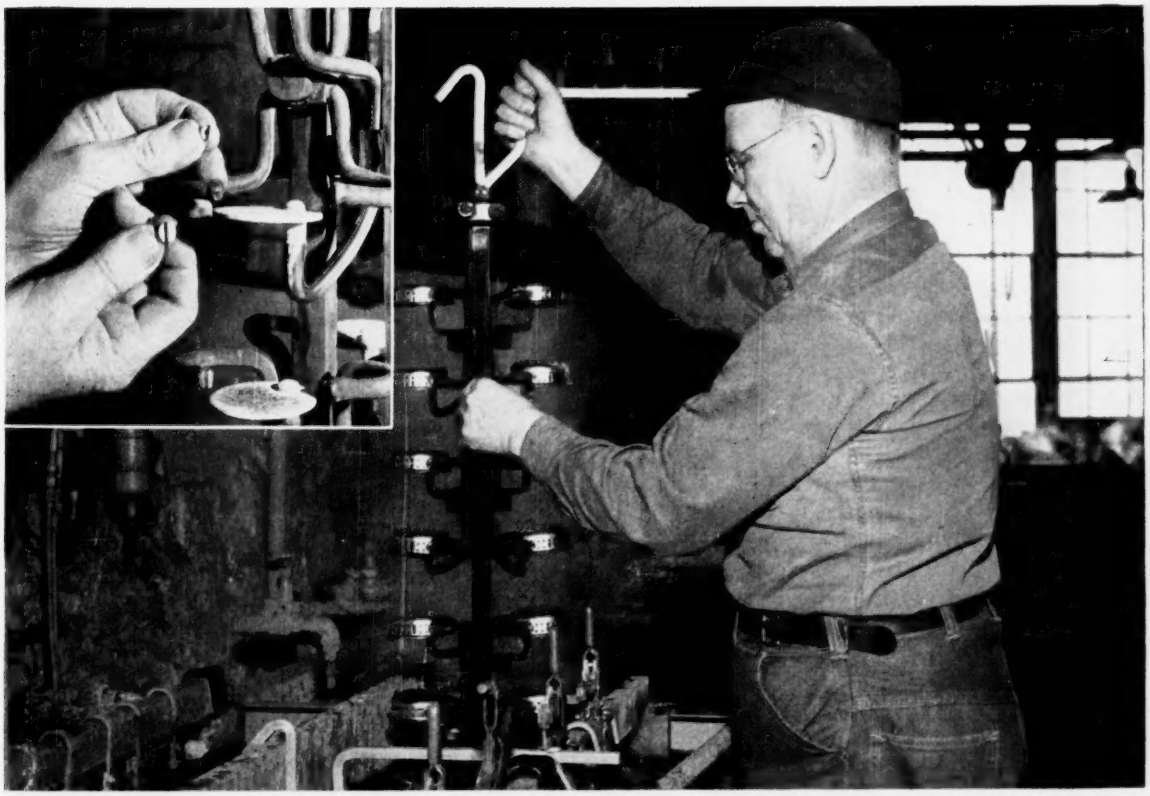

Electropolishing racks covered with HYPALON are in good condition after six months. If product changes make racks obsolete, new adapters can be mounted on existing splines.

IN ELECTROLYTIC POLISHING

HYPALON® Outlasts Other Materials 8 to 1

HYPALON's resistance to strong oxidizing chemicals can save you time and maintenance dollars. Every year the metal finishing industry spends millions of dollars maintaining plating and electropolishing racks. The reason: the protective coating on ordinary insulated racks often deteriorates in a short time.

In Cleveland, the Guarantee Specialty Manufacturing Company has been using a new type of electropolishing rack protected with a vulcanized cover of Du Pont HYPALON. Despite six months of exposure to phosphoric acid, no failure has been discovered. Three weeks was a good life for the ordinary coating on the old racks, yet recent examinations indicate that HYPALON will continue to give favorable performance.

Similar racks are in electroplating service at automobile plants. Reduced downtime is saving money, but there are other advantages for electroplaters. The tight bond between the rack and the vulcanized HYPALON cover eliminates pockets, and the smooth surface permits rapid run-off, reducing drag-out losses and the risk of contaminating solutions.

HYPALON offers more than resistance to chemicals. It's ozone-proof, and it performs well in temperatures up to 350° F. For more information on its properties and uses, mail coupon below.

ELASTOMERS IN ACTION HYPALON® • NEOPRENE

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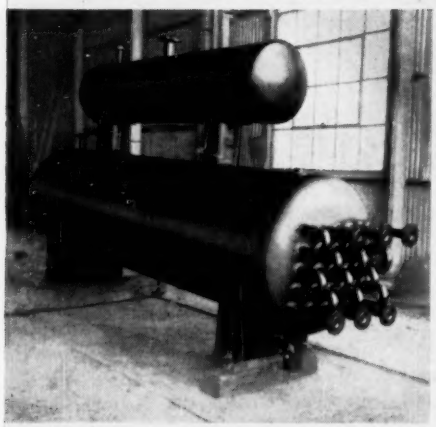
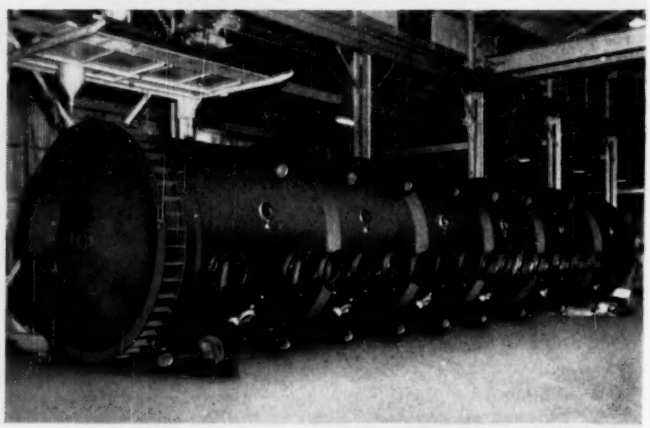
Fractionating Column—72" Dia. X 110'-0" length, ¾" wall thickness with 40 trays. All welds 100% X-ray quality. Constructed for internal pressure and full vacuum. Stamped A.S.M.E. Code. Total weight 83,000 lbs.



Heat Exchanger — Lower Section 4'-0" dia. X 14'-0". Upper Section 1'-8" dia. X 10'-0", ⅝" Carbon Steel Plate Wall. A.S.M.E. Code construction using tube bundle of schedule 160 pipe.



Styrene Stripping Column—9'-6" Dia. X 80'-0" length, ½" plate walls and ⅝" heads. Constructed and stamped A.S.M.E. Code. Vessel contains 14 stainless steel perforated trays, 16 manways, 146 couplings, and nozzles. Total weight 72,000 lbs.

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MODERN WELDING COMPANY

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Large-diameter flexible metal connectors in stainless steel and other alloys—to handle expansion and contraction, wide range of temperatures, corrosive fluids, high pressures, and vibration.

Jet engines, modern chemical plants, rockets, atomic energy plants have created a new technology that calls for new products. The American Metal Hose Division of The American Brass Company is constantly working with design engineers on special flexible connector assemblies to meet new problems.

Equipped to work in stainless steel, Monel, and aluminum as well as in other alloy steels and copper alloys, these Anaconda specialists welcome the opportunity to help you get the flexible metal hose you need to meet your problems of expansion and contraction, movement, vibration, corrosion, pressures, and temperatures.

FREE TECHNICAL SERVICE. For engineering assistance on special products—or for a free copy of our General Catalog showing the full line of standard American Flexible Hose and Tubing products—write: The American Metal Hose Division, The American Brass Company, Waterbury 20, Connecticut.

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FLEXIBLE METAL HOSE AND TUBING
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American Metal Hose Division, Waterbury 20, Conn.

Please send me your free, 60-page General Catalog containing basic information on all types of metal hose and tubing, fittings, etc.

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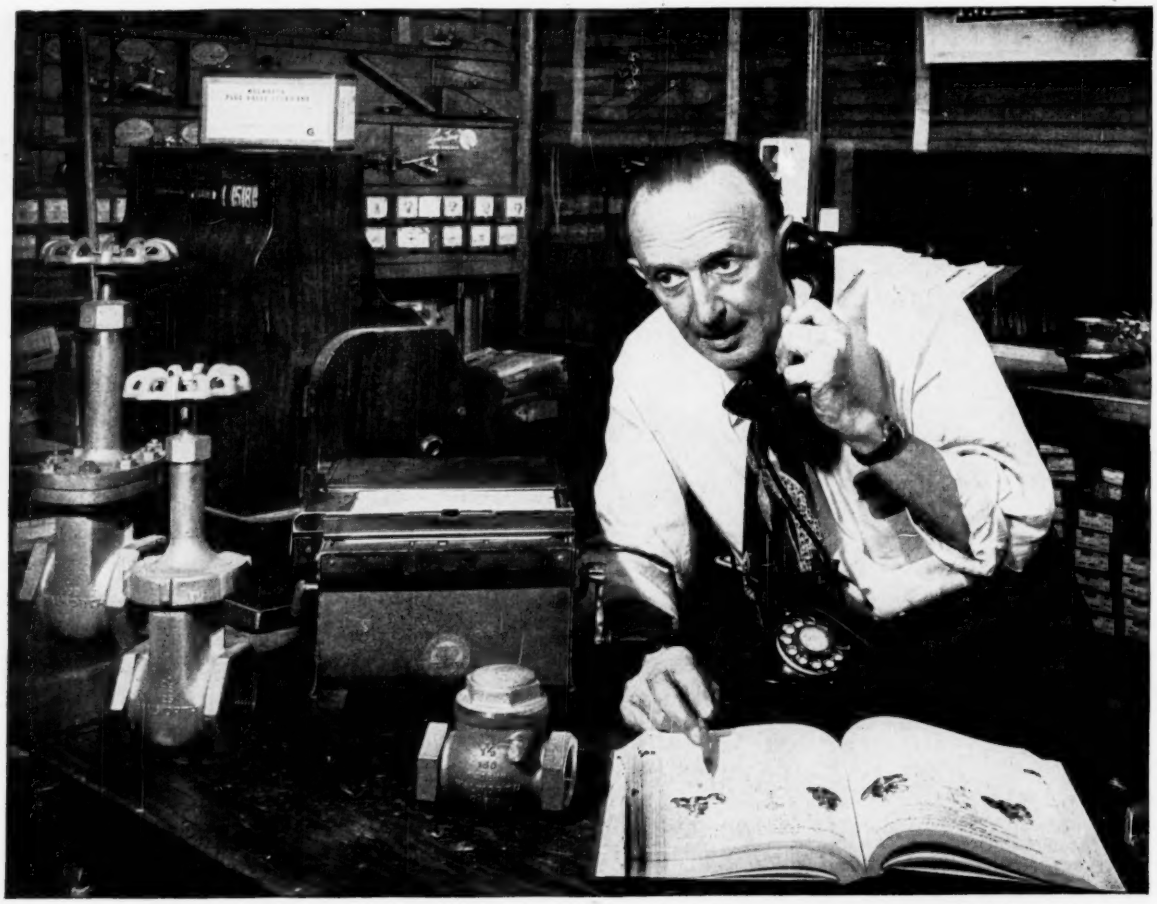

*Fictitious name used to typify over 400 Walworth Distributors

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Andy Hansen is typical of Walworth Distributors throughout the nation. He has been a distributor of Walworth Valves and Fittings for years. Like Andy, the Walworth Distributor in your area provides these services and savings:

He reduces your inventory costs. He's aware of the valve and fitting needs peculiar to his area. He stocks the products that will best serve your needs. Deliveries are always prompt and economical – emergency orders can generally be delivered within hours.

He offers you application and engineering assistance. His technical experience can be invaluable in solving your particular problems. He has 50,000 Walworth products at his disposal. You can be sure that the items he recommends are exactly right for the job.

He is a double guarantee. His business depends upon providing you with the very finest products and unsurpassed service. Every valve and fitting is backed by his own reputation and that of Walworth – a complete line manufacturer.

There's a Walworth Distributor near you ready to help. Call on him today.

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U.S.I. CHEMICAL NEWS

June ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

New Electron Beam Melting And Casting Process Gives High Purity Special Metals

A new process employs electron beam bombardment in a high vacuum to melt special metals such as titanium, zirconium, tantalum, molybdenum, columbium, beryllium and vanadium. A company to commercialize this process has just been formed jointly by Stauffer Chemical, Temescal Metallurgical and Mallory Sharon Metals (the last named company is owned ⅓ by U.S.I.).

Techniques have been developed which permit certain impurities to be volatilized and removed, yielding metals of unusually high purity with properties not attainable by other methods. The process will make these high purity metals available for the first time in commercial quantities.

In this process, heat for melting is supplied by an electron gun which serves as the cathode and bombards the melt stock (the anode) with electrons, heating it to the melting point. Molten metal drops into a water-cooled

MORE

AEC Plans Another Sodium-Cooled Reactor Experiment

The Argonne National Laboratory has announced that a second Experimental Breeder Reactor (EBR-II) will be constructed at Arco, Idaho. It will be sodium-cooled with an electrical power output rated at 20,000 KW, and is expected to go critical in June 1959. Arco is also the site of Experimental Breeder Reactor-I, which is cooled with a sodium-potassium mixture and has an output of 15,000 KW.

The purpose of EBR-II will be to develop engineering and operation information which can be applied to full-size, central-station power plants. This reactor will contain complete fuel processing and fabrication facilities, heat transfer systems and steam electric plant.

Metallic sodium makes an excellent coolant because of its relatively low neutron-absorbing characteristics, good heat transfer properties, low melting point and high boiling point. High temperatures without high pressure can be produced when sodium is used as coolant.

MORE

New Coating Protects and Decorates Polyethylene

Films and molded products made of any type of polyethylene can now be decorated and/or protected with a new synthetic coating which is applied by dip or spray techniques. The material, tradenamed NYLENE, is reported to impart a hard, glossy finish and to increase clarity of polyethylene products. Excellent adhesion, flexibility and scuff resistance are claimed, along with resistance to a wide range of solvents. The new coating also acts as a vapor barrier.

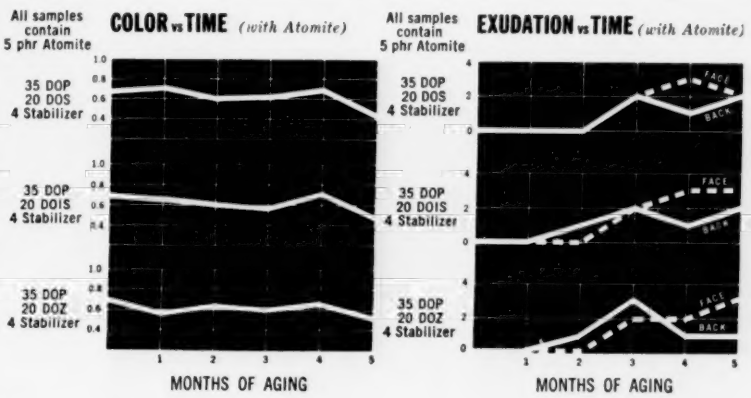
Because the coating can be tinted in any color, and combined with metallic powders, it is suggested for decorative purposes.

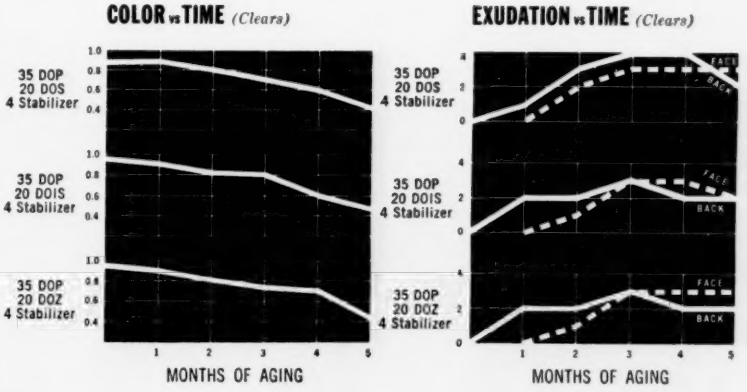
Advantage of Isosebacate Plasticizers Shows Up in Aging Tests on Vinyl Film

Dioctyl Ester of ISOSEBACIC® Acid Comparable to Corresponding Esters of Sebacic, Azelaic Acids in Performance, Lower in Cost

A five-month series of aging tests was conducted recently in Southern Florida by an independent research laboratory to determine color stability and exudation rates in vinyl films containing various plasticizers. In these tests it was demonstrated that the dioctyl ester of ISOSEBACIC acid is comparable in performance to the same esters of sebacic and azelaic acids when used as vinyl plasticizers. At the same time, the ISOSEBACIC acid ester is lower in cost.

The charts below show actual test results. ISOSEBACIC acid, a mixture of C-10 dibasic acids, was developed in the U.S.I. research laboratories. A commercial plant for production of this intermediate is being started up at U.S.I.'s Tuscola, Ill. chemical complex. Samples are available on request.


All samples contain 5 phr Atomite
COLOR vs TIME (with Atomite)
35 DOP 20 DOS 4 Stabilizer
35 DOP 20 DOIS 4 Stabilizer
35 DOP 20 DOZ 4 Stabilizer
MONTHS OF AGING
All samples contain 5 phr Atomite
EXUDATION vs TIME (with Atomite)
FACE
BACK
MONTHS OF AGING



Note: 1.0 = Colorless

DOP — DIOCTYL PHTHALATE
DOS — DIOCTYL SEBACATE
DOIS — DIOCTYL ISOSEBACATE
DOZ — DIOCTYL AZELATE
PHR — PARTS PER HUNDRED RESIN

Charts courtesy of Deecy Products Company

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

June ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Electron-Beam Melting

copper crucible below and is not contaminated by the crucible.

Electron beam melting is said to offer several important advantages over vacuum arc melting. Operations can be stopped and started at any time. Materials can be melted in any form: ingot, powder, flake or sponge. Under the conditions existing in the furnace, gaseous impurities are removed rapidly as suboxides to leave behind the pure metal.

The process can also be used for zone refining. There is no apparent limitation on the diameter of the bar or ingot that can be processed, and so a large quantity of purified metal can be turned out in a relatively short time.

The new process will be licensed to interested industrial and research concerns.

Non-Beverage Alcohol Regulation Clarified

A new ruling by the Alcohol and Tobacco Tax Division of Internal Revenue clarifies a 1956 regulation concerning the filing of alcohol formulas when a company changes ownership. Revised Ruling 58-123 states that when a non-beverage manufacturing operation undergoes a change in proprietorship, and the new owner wants to use the alcohol formulas filed by the preceding owner, he must follow one of two procedures.

He can submit new formulas in his own name on Form 1678, Formula and Process for Non-Beverage Product, to replace those submitted by his predecessor. Or he can adopt the formulas already on file by submitting an affidavit to the Assistant Regional Commissioner, Alcohol and Tobacco Tax, stating that the preparations covered by formulas submitted by the prior owners, and on file with Internal Revenue, will be made in accordance with such approved formulas and processes.

The affidavit must identify the formulas by serial numbers and names of products. The original and two copies go to the Assistant Regional Commissioner who sends one copy to the Director, Alcohol and Tobacco Tax Division. A fourth copy should be retained by the manufacturer.

CONTINUED

Sodium in Reactors

Four other U.S. sodium-cooled reactors range in status from operational to the development stage. They are:

Sodium Reactor Experiment, Santa Susana Mts., Cal. — sodium-graphite reactor — 7,500 KW (operational)

PRDC Fast Power Reactor, Monroe, Michigan — fast breeder reactor — 100,000 KW (under construction)

Consumers Public Power District, Hallam, Neb. — sodium-graphite reactor — 75,000 KW (design stage)

Chugach Electric Association Reactor, Anchorage, Alaska—heavy water-moderated, sodium cooled—10,000 KW (development stage)

Chemical P.A.s Meet With Market Research Group

The Chemical Buyers Group of the National Association of Purchasing Agents met for the first time with the Chemical Market Research Association in Washington recently.

It was felt that market research groups can help P.A.s in major purchasing decisions, particularly in the "make-or-buy" area. Chemical buyers said that today they need information on distribution, consumption and future market trends as much as skill in negotiation in order to make intelligent, profitable purchasing decisions.

Conversely it was felt that P.A.s can give market research men data on current conditions, for developing market forecasts.

SOLOX® Denatured Alcohol Proves Versatile on Boats

With the boating and fishing season now getting into high gear, U.S.I.'s general purpose denatured alcohol solvent SOLOX is becoming increasingly popular with boat owners and campers. SOLOX has many cleaning uses — for wiping off sanded wood before painting, to dry the wood and clean out dust at the same time; with soap to wash painted surfaces; with water for cleaning glass; full strength for cleaning motors and ignition parts.

SOLOX is also an efficient fuel, and igniter for fuel, in boat and camp stoves.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Triethylborane is now being supplied in sample quantities for study as a catalyst for polymerization of unsaturated monomers, as a jet fuel or fuel component, and as an igniter or flame-speed accelerator. **No. 1360**

Equipment for radio-active operations is described in a new book now being sold. The volume contains some 60-odd papers delivered at the Hot Laboratories and Equipment Conference held as part of the 1957 Nuclear Congress. **No. 1361**

Thermoplastic adhesive in dry, 100% solid, continuous cord-like form, is now being marketed with applicator especially designed for controlled feeding, melting and applying. Claimed to bond polyethylene films, coatings, papers, boards, foils, glassines at 250 ft./min. **No. 1362**

Air pollution is the subject of a free, 20-page booklet just issued to help develop fair and workable air pollution laws. Principles essential to such legislation are defined. Procedures for formulating these laws are outlined. **No. 1363**

New corrosion-resistant, thermosetting coating for chemical plant floors is said to resist strong acids, alkalis and solvents, withstand temperatures of 230 F, support heavy traffic. Sets quickly to durability of good concrete. **No. 1364**

Carbon-14, tritium and sulfur-35 samples in solid, liquid and vapor phases can be measured for radioactivity with new dynamic condenser electrometer. With flow chamber, instrument claimed ideal for industrial gas monitoring. **No. 1365**

New adhesive for laminating urethan foam and combining it with all types of surfaces is said to impart immediate high tensile strength and excellent adhesion in heat or pressure-sensitive sealing. **No. 1366**

Encyclopedia of Chemical Technology has just been brought up-to-date through issuance of the first supplement volume to this series. It contains 51 articles covering, among other topics, adhesives, computers, nuclear reactors. **No. 1367**

New portable oxygen indicator is now available for measuring concentrations of oxygen in gaseous mixtures from 0 to 25% by volume. Operates on a single flashlight battery, weighs less than six pounds. **No. 1368**

Zirconium and hafnium technical and application data are covered in a new 16-page brochure now available at no charge. Production, properties and mill shapes available are included, as well as present and future commercial uses. **No. 1369**

PRODUCTS OF U.S.I.

ORGANIC SOLVENTS, INTERMEDIATES

Plastics Intermediates: ISOSEBACIC® Acid, Sebacic Acid.

Alcohols: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil.

Esters: Ethyl Acetate (85-88%, 95-98%, 99%), Normal Butyl Acetate, Diethyl Carbonate, DIATOL® (Diethyl Carbonate Containing About 10% Anhydrous Ethanol), Diethyl Oxalate.

Ethers and Ketones: Ethyl Ether (Technical, Absolute, USP), Acetone (Dimethyl Ketone).

Intermediates and Fine Chemicals: Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, 2-Ethyl Heptanoic Acid.

OTHER PRODUCTS

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

PETROTHENE® Polyethylene Resins

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corporation
99 Park Avenue, New York 16, N. Y.

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WASTE HEAT FROM STACKS LIKE THESE COULD PAY 1/5 OF YOUR FUEL BILL

A Ljungstrom® air preheater can cut 20% off your fuel bill by getting more heat from your fuel. That means you burn less of your regular fuel to get the same operating temperature, or you can switch to cheaper fuels without affecting product quality. Either way, every barrel of output can cost 20% less in fuel.

A Ljungstrom air preheater gets more productive heat from any fuel by boosting the temperature of the combustion air – sometimes as much as 1000F. Fuel burns more completely in preheated combustion air, and leaves less slag and deposit behind, so the fuel-burning equipment stays efficient longer.

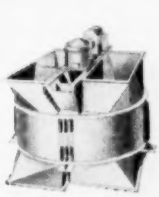
How fast is "WRITE OFF"?

What you save on fuel can pay for the Ljungstrom in two years. If you take advantage of the extra capacity of a Ljungstrom-equipped system to increase output or to improve product quality, the Ljungstrom can pay for itself within nine months.

Write today for your copy of a factual article by Mr. O. F. Campbell of Sinclair Refining Company, describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

PHOTOGRAPHED UNDERWATER AT FLORIDA'S SILVER SPRINGS

Underwater is home for this motor!

New Louis Allis Immersible motor is built to operate in water, sewage, or liquid chemicals

The Immersible motor can be adapted to operate in any kind of liquid — fresh or salt water, sewage, chemicals, or abrasive industrial cutting oils. It's the ideal means to provide power in a vat or sump — at the bottom of a pool, lake, or ocean!

No matter how deep your setting, the Immersible motor provides close-coupled power — saves you the need for expensive jack-shafting, intermediate bearing supports between pump and a surface-mounted motor, and mounting structures.

The motor is oil-filled and sealed at the factory. Diaphragm breathers equalize internal and external pressure — eliminate pressure at the shaft seal and prevent leakage. All joints are sealed to keep water and dirt out. Vinyl-coated housing and stainless or suitably plated exposed parts resist corrosion. Mating surfaces of the housing and flange are precisely machined to provide accurate alignment of the pump impeller and casing.

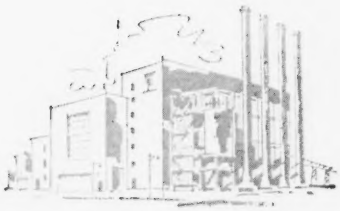
The Immersible, as shipped, is ready for horizontal or vertical mounting on pumps, agitators, mixers, or special equipment. Sizes range from ¾ to 40 hp. For additional information contact your local Louis Allis District Office, or write for Bulletin 2300, The Louis Allis Co., 447 E. Stewart Street, Milwaukee 1, Wisconsin. But do it today!

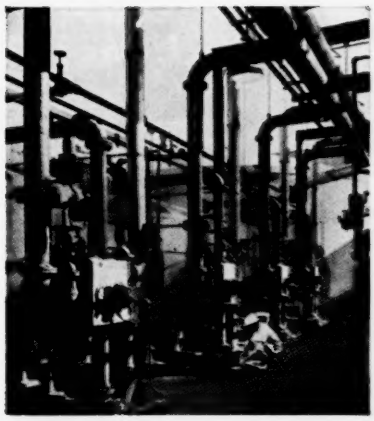
SM-109

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

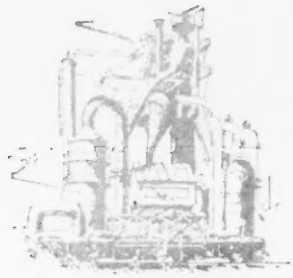
First in water conditioning

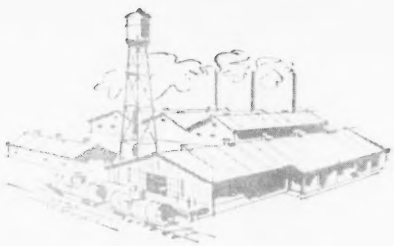




Cochrane *automatic* Zeolite Softening

at RAYONIER'S GIANT JESSUP PLANT





To produce high-quality cellulose requires high-quality water. At Rayonier's Jessup, Ga. plant, more than 20 million gallons of water are softened daily—and all of it softened automatically to zero hardness by 22 Cochrane Zeolite Softeners.

The softeners in this installation are controlled by Cochrane Hydromatic Valves, which in turn are controlled by Cochrane Automatic Timers. Every phase of the cycle—service, backwash, regeneration, rinse and back to service are all automatically controlled.

Zero hardness water is guaranteed. There is no possibility of error in operation or of contaminating the treated water.

Cochrane's leadership in water conditioning, and its complete line of equipment assure you unbiased recommendations for equipment to performance requirements. For complete information on Cochrane Zeolite Softeners, write for Publication 4520-A.

Cochrane
CORPORATION
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Cochrane Water Conditioning Ltd., Toronto 4; Montreal 1, Canada
Representatives in 30 principal cities in U.S.; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii; Manila, Philippine Islands.
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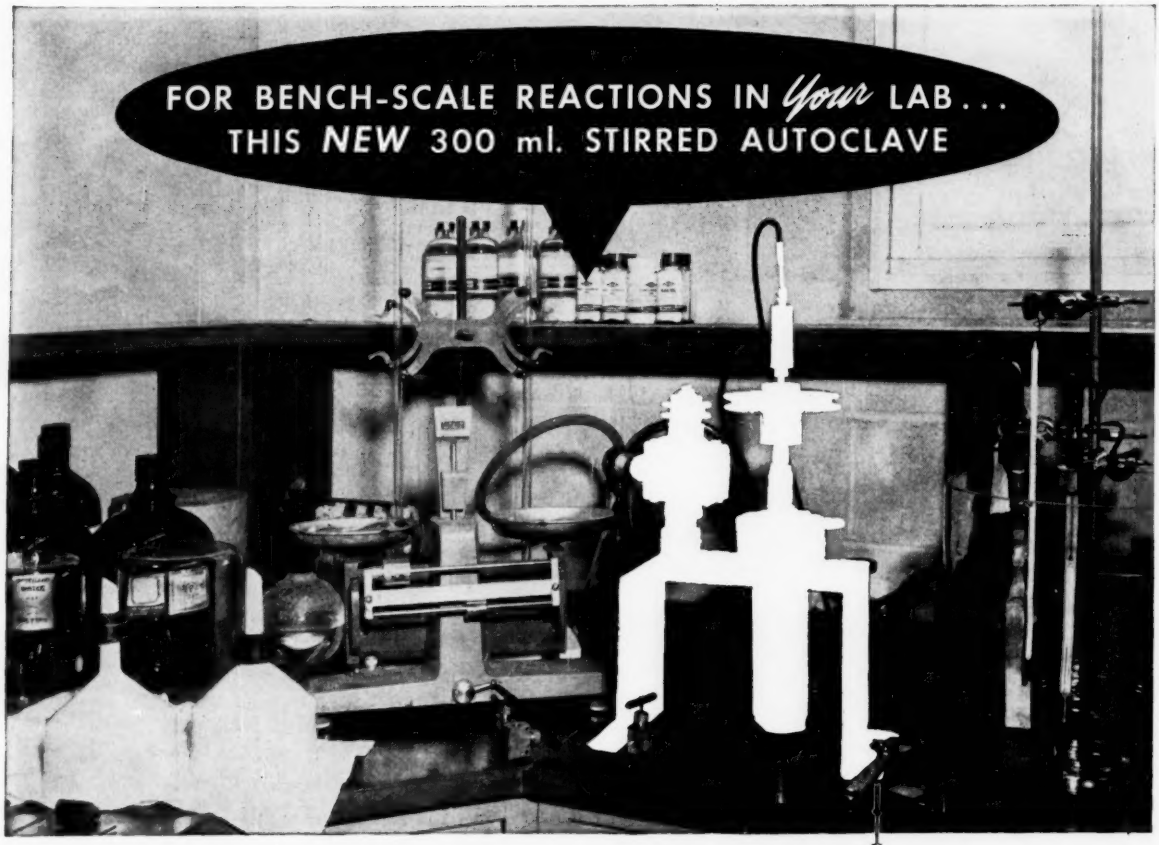


COMPACT • INEXPENSIVE
EASY-TO-HANDLE

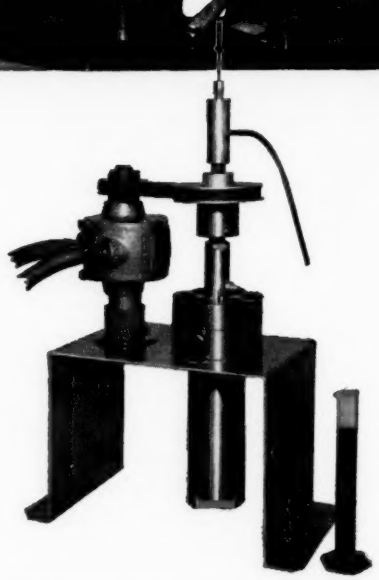
Your Choice Of Air Or Electric Drive

Here is the answer to your need for a bench-scale stirred autoclave you can use in a wide range of pressure reactions. This new AE vessel has a capacity of 300 ml. and is designed for pressures up to 5000 p.s.i. at 650°F. It is a self-contained unit ready for connection to existing utilities in your own laboratory. Equipment includes agitator, cooling coils, electric heating, sampling tube, charging opening, gas openings and your choice of either air or electric drive.

You'll especially like the compact size of this AE ***BENCH-SCALE*** unit. For example, the unit shown here occupies a space of only 7″ x 13″ x 20″ high. Simplicity of design and light weight are other features that assure easy handling and operation.

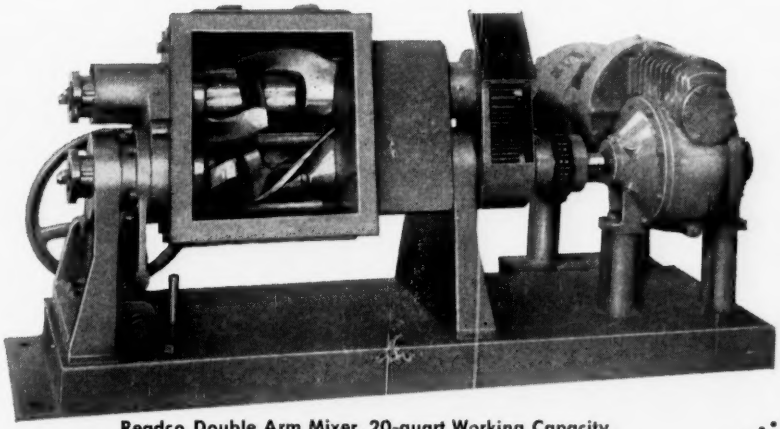
The body of the vessel and all wetted parts are made of 316 stainless steel. A complete line of valves and fittings for use with the unit are also available.

Complete specifications are described in Bulletin 1257-1. Send for your copy today.



AE ***BENCH-SCALE*** Stirred Autoclaves are compact. Model ABA-300 shown here is 7″ x 13″ x 20″ high.

AUTOCLAVE ENGINEERS, INC.
2932 WEST 22nd STREET, ERIE, PENNSYLVANIA



Readco Double Arm Mixer, 20-quart Working Capacity

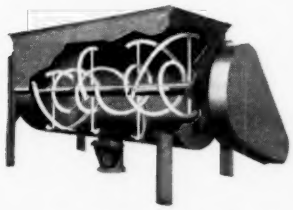
Predict production precisely with READCO Lab and Pilot Plant Mixers

READCO

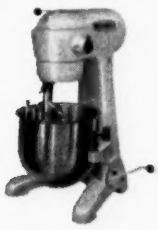
Incorporating all the basic design features of larger production models, Readco Laboratory and Pilot Plant mixers enable you to make accurate forecasts for commercial processing.

Mixing bowls are accurately machined and fitted . . . have vacuum covers and temperature controlling jackets. Overlapping sigma mixing arms are held in constant close clearance, eliminate dead spots, prevent build-up of materials, aid temperature control. Easily interchangeable mixing arms adapt to various materials or processes.

Ruggedly built of Type 316 stainless steel, or any commercial alloy, Readco lab and pilot plant mixers will efficiently handle even heavy viscous material. They are available from stock in 1, 3, 6, 20 and 40-quart working capacities, with fixed or variable speed drives. For more information see Chemical Engineering Catalog, pages 1483-1490 . . . or write direct.



Readco Spiral Ribbon Mixers—Batch or Continuous. Standard sizes 1 to 500 cu. ft. working capacities.



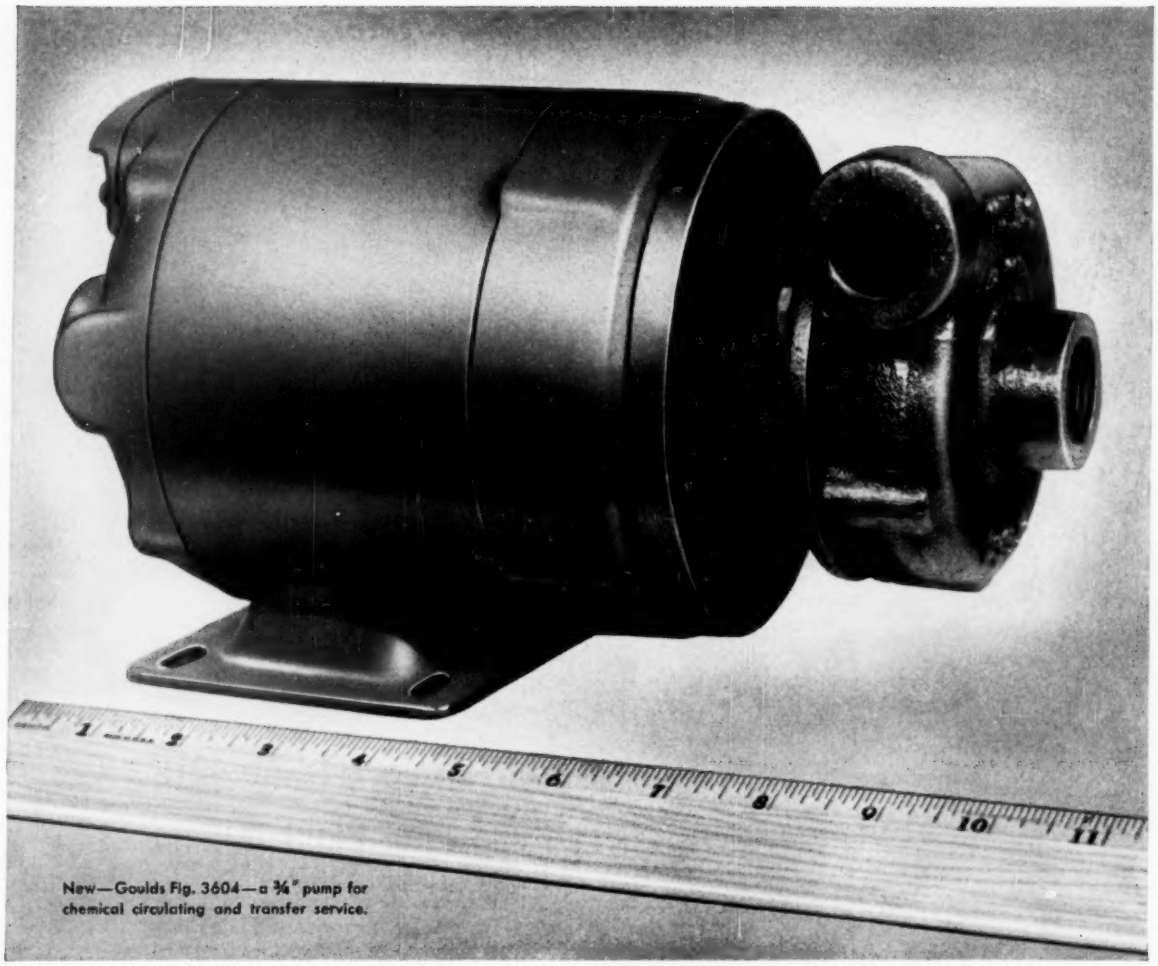
Readco Vertical Mixers, planetary action, multiple speed, 12 to 175 qt. working capacities. (Model K-20 illustrated)

Whatever the mixing job . . . a READCO mixer!

READ STANDARD

York, Pennsylvania

A Division of Capitol Products Corporation



New—Goulds Fig. 3604—a ¾" pump for chemical circulating and transfer service.

Here's a small pump with big-pump stamina

Ideally suited for handling corrosive materials

Small, compact—this new pump fits in where space is a problem. But you can rely on it for continuous service round the clock, round the calendar.

It's available from stock in 316 Stainless Steel—which provides the widest and most economical coverage of liquids commonly handled by a pump of this type.

The mechanical seal—with carbon, Teflon, stainless steel and ceramic parts—is noncorrosive.

The impeller clearance is externally adjustable to compensate for wear.

The pump is small enough (10½ x 5½ x 5½) and light enough (23 lbs. with motor) for lab or pilot plant operations. It's designed for temperatures to 220° F. and working pressures to 75 p.s.i. Capacities to 16 GPM and heads to 28 ft.

For circulating duty, as a component in larger equipment, this new Goulds chemical pump offers advantages in size, weight, cost, and dependable performance.

Complete information on this high-quality pump—performance curves and specifications—is offered in Bulletin 624A4. You can get a copy from your Goulds representative, or by writing us.

GOULDS

PUMPS FOR CORROSIVES

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK
Main Office and Works

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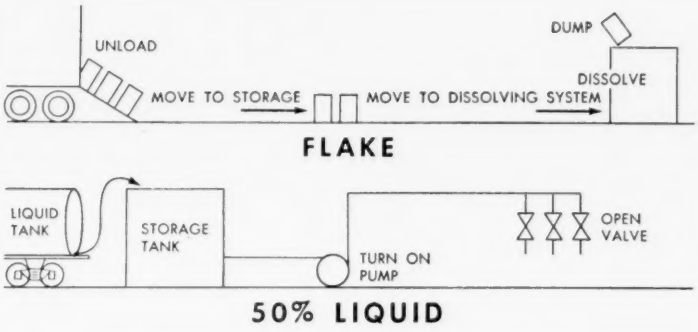
BRIEFS for buyers of

Caustic Soda
Sulfur Chlorides
Trichlorobenzene
Caprylyl Chloride



How flake caustic soda users might save some money

If you use flake caustic soda in tonnage quantities, you might save quite a few dollars by switching to Hooker 50% liquid.

Flake caustic soda takes a lot of handling. In fact, it probably costs you as much as $4.00 per ton or more in handling *inside your plant*. Flake costs more than liquid to start with, too.

Besides being lower priced, many users estimate that 50% liquid caustic costs less than $1.00 per ton of caustic soda in plant handling.

Call your Hooker contact to help you compare prices and freight rates along with equipment costs. You'll never know what savings you might make until you do.

The coupon will bring you data sheets on both flake and liquid caustic soda.

Some facts on $C_6H_3Cl_3$

Hooker Trichlorobenzene, Technical, is a mixture of the 1,2,3- and the 1,2,4-isomers in a clear, practically colorless liquid.

It has wide use as a general solvent for fats, oils, waxes, and resins. With no flash or fire points up to its boiling point, it is of interest as a non-flammable heat transfer medium in the range of 210-300° C. Other uses are as an intermediate for preparation of dyestuffs and other organic chemicals.

Additional physical properties, use data and complete specifications are listed in our data sheet.

Check the coupon for a copy.

Why we make a better caprylyl chloride

Improvements in fatty acid processing have enabled us to obtain caprylic acid of substantially increased purity over that of former years. This results in a caprylyl chloride of 90-95% purity, with only small quantities of the hexanoyl and decanoyl chlorides. Another edge that we have in producing this and other acid chlorides is our basic position in chlorinating agents.

The Hooker product has a typical chlorine content of 21.8%. 90% distills in the range of 183-212° C. Its freezing point is below minus 70° C.

For complete specifications and additional typical data, check the coupon.

SCl_2 or S_2Cl_2

Which is better for your chlorination?

The sulfur chlorides are closely related and are good, low cost chlorinating agents. For actual use, various factors determine which of the above may be preferred as the chlorinating agent. We manufacture both products and can supply whichever you require for your own particular operations.

Hooker sulfur monochloride is a yellow to slightly red liquid with 52-52.5% chlorine. Hooker sulfur dichloride is brownish-red in color and contains a minimum of 66% chlorine.

There are a number of helpful tips on which product to use as well as information on other Hooker chlorinating agents including sulfuryl chloride and thionyl chloride in our bulletin 328-A, "Chlorinating Agents." Check the coupon for your copy. Data and specification sheets on each product are also available.

For more information, check here:

- ☐ Caustic Soda
- ☐ Caprylyl Chloride
- ☐ Trichlorobenzene
- ☐ Sulfur Monochloride
- ☐ Sulfur Dichloride
- ☐ Bul. 328-A, Chlorinating Agents

Clip and mail with your name, title, and company address. When requesting samples, please use business letterhead.

HOOKER ELECTROCHEMICAL COMPANY
406 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

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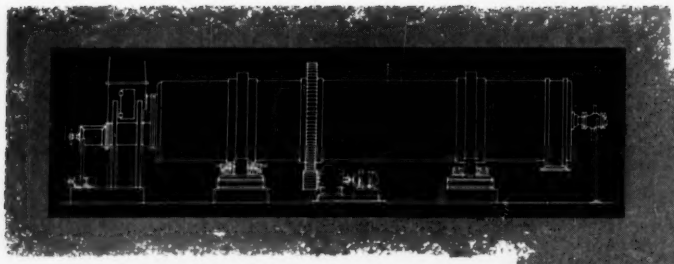
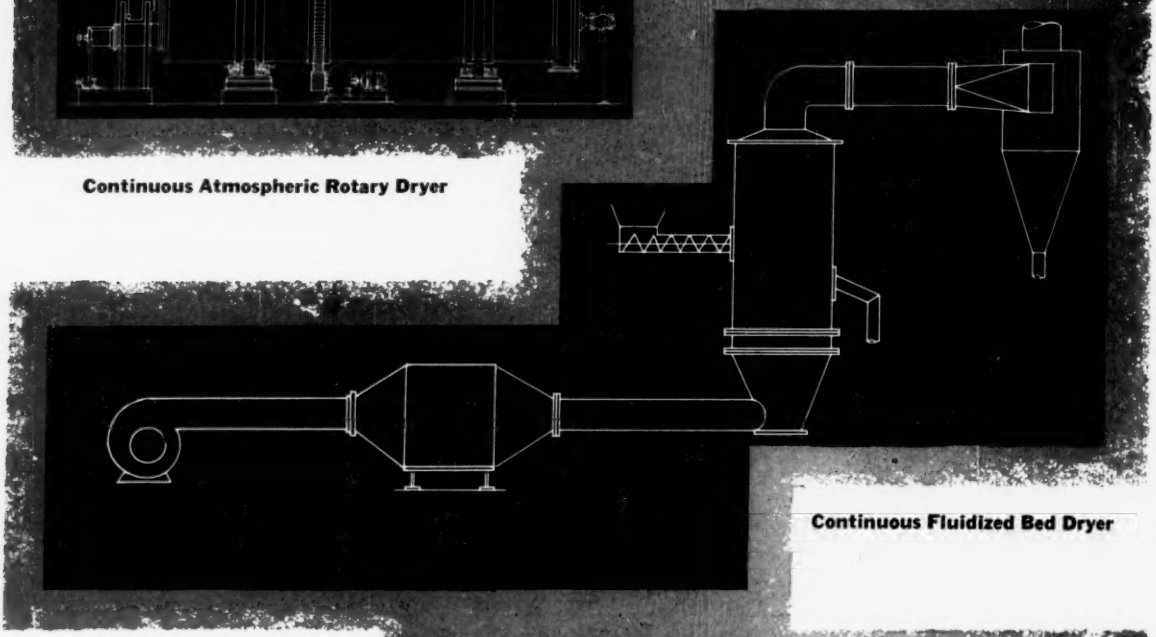
HOOKER CHEMICALS PLASTICS

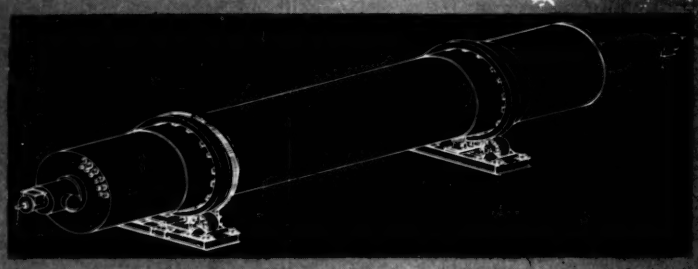


Continuous Atmospheric Rotary Dryer



Continuous Fluidized Bed Dryer

Continuous Solvent Stripper
Continuous Gas Solids Reactor
Continuous Vacuum Dryer



Now, at one convenient location, you can test-dry your materials in a variety of equipment

At General American's East Chicago pilot plant, you can test the drying or reacting of your materials in the widest range of drying equipment ever assembled in one place.

Louisville Dryer engineers will work with you—study your materials and needs, make recommendations for type of equipment, size and heating medium. You can check these recommendations for yourself through practical tests. Your Louisville Dryer is then engineered for most efficient and economical service—built specifically to meet your needs.

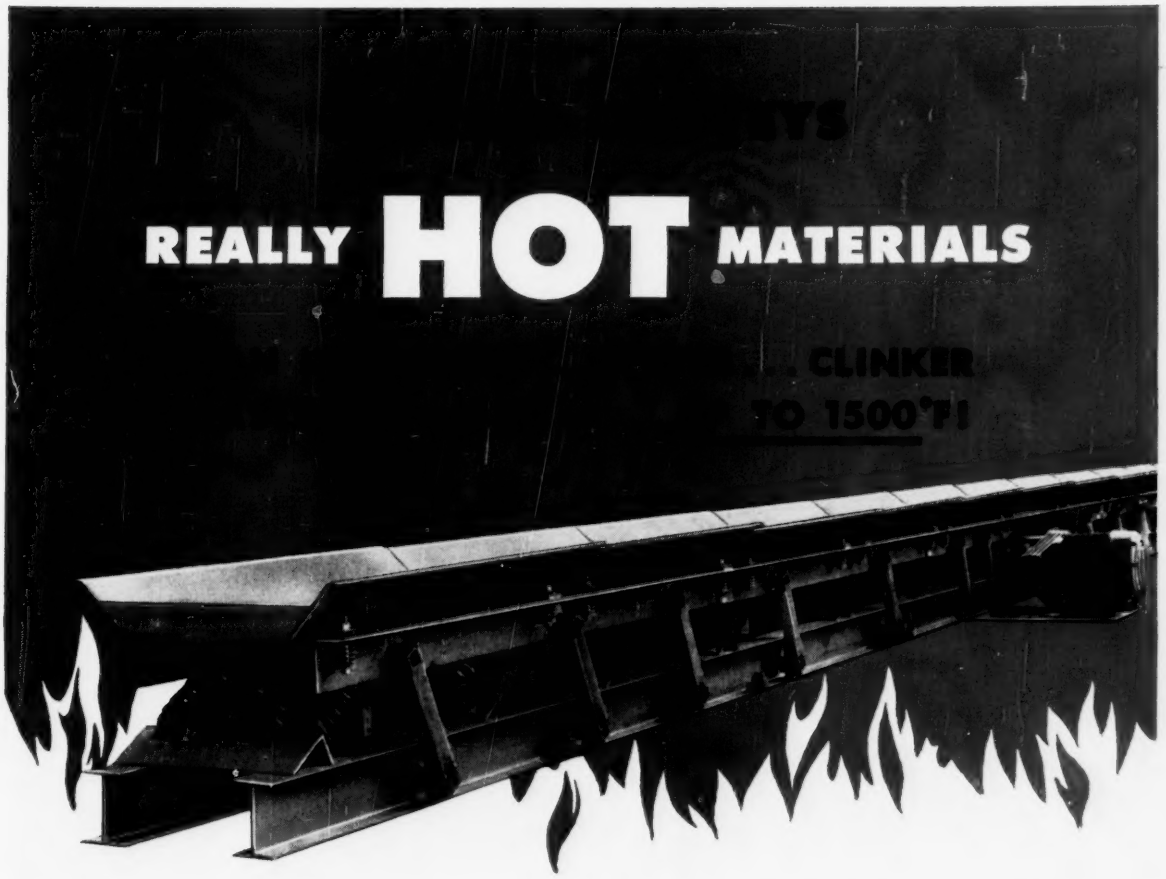
To test the drying of your materials in all these different types of drying equipment, call in a Louisville Dryer engineer. There is no cost or obligation.

PROCESS EQUIPMENT DIVISION
GENERAL AMERICAN
TRADE MARK

LOUISVILLE DRYING MACHINERY UNIT

GENERAL AMERICAN TRANSPORTATION CORPORATION

Dryer Sales Office: 139 S. Fourth Street, Louisville 2, Kentucky • Eastern Sales Office: 380 Madison Avenue, New York 17, New York • In Canada: Canadian Locomotive Company, Ltd., Kingston, Ontario, Canada
General Offices: 135 South La Salle Street, Chicago 90, Illinois.



- **Heavy Conveying Troughs** — ½" thick and heavier. Widths to 6', lengths to 500'. Easily vibrated in 1" stroke by rugged coil springs and single patented Carrier Natural-Frequency Drive.
- **Expandable Trough Sections** — Each 5' trough section attached by spring-loaded bolts through slotted holes. Sections expand independently of each other and of conveyor's structural members.
- **No Leakage** — A continuous one-piece dribble trough (not shown) mounted several inches below the conveying trough collects any fines which may leak through the conveying trough sections.
- **Replaceable Trough Sections** — New conveying trough sections easily installed. Little delay. Convenient replacement principle cuts costly down-time.
- **Heat-Resistant Materials** — Alloy and stainless steels resist warping and high-temperature scaling. Low abrasive wear due to gentle conveying action.
- **Quenching or Cooling** — Can be accomplished by direct or indirect water spray, plate-coil deck, or air.
- **Heat-Protected Drive** — Heat protection provided by heat shield, dribble trough, and flexibility of location.

CARRIER NATURAL-FREQUENCY® CONVEYORS

Carrier Conveyor Corporation
256 North Jackson Street
Louisville 3, Kentucky

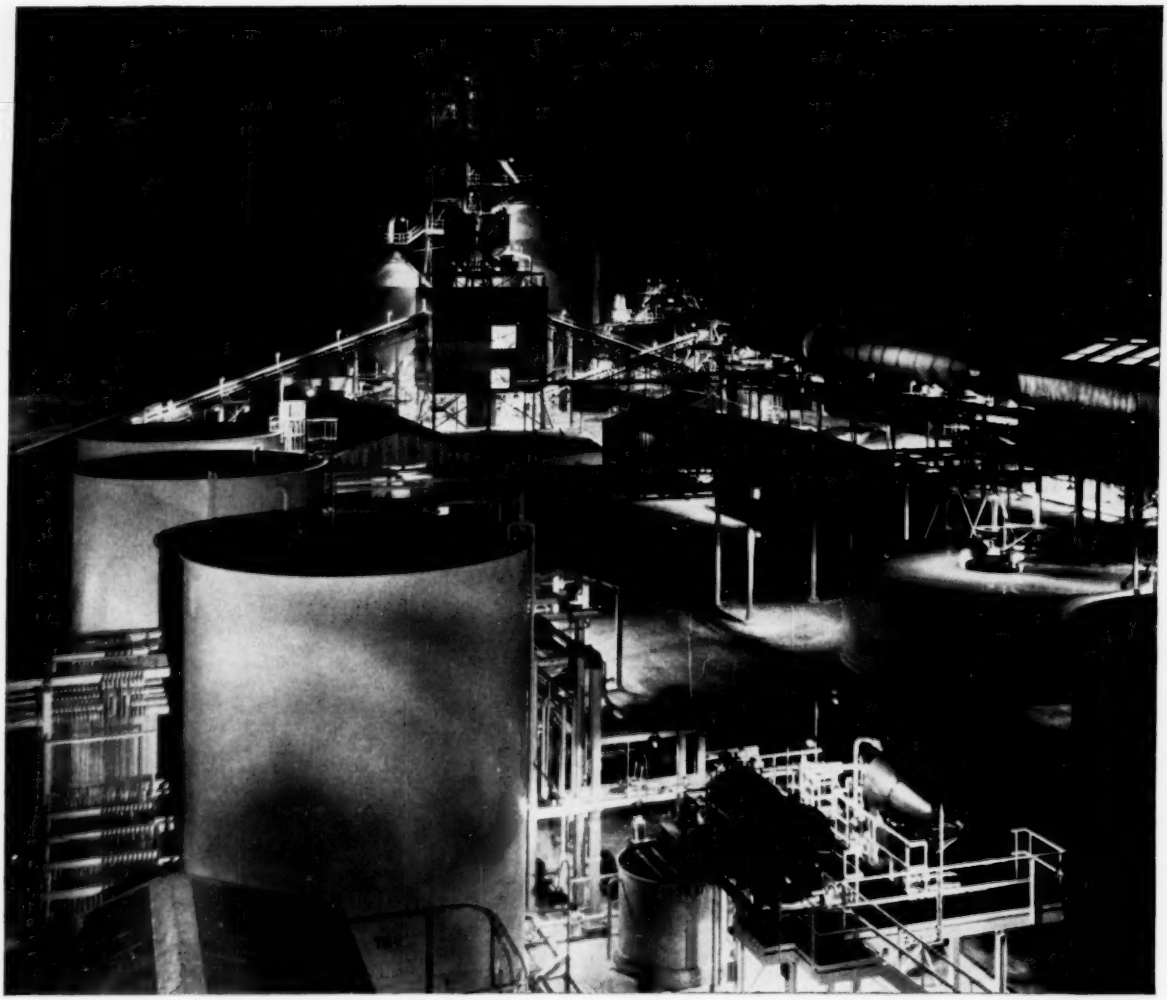
Please rush full information on Carrier Natural-Frequency High-Temperature Conveyors.

Company_____

Name_____

Street_____

City_____ State_____



56 Tanks for First Large Plant to Produce Lithium Hydroxide from Lepidolite Ore

In fifteen short years, many uses have been found for lithium and its compounds—as a coolant for nuclear reactors, as an all-purpose lubricant, as a catalyst in polymerization, as a factor in making rocket fuel, to name a few.

Large quantities of lithium hydroxide are now assured by the construction of the first commerical plant for producing the compound from lepidolite ore. This new plant was designed and built by C. F. Braun and Co. for American Lithium Chemicals, Inc., at San Antonio, Texas, a subsidiary of American Potash & Chemical Corporation. All 56 tanks, of carbon steel, from the largest of 635,000 gallons to the smallest of 450 gallons, were fabricated and erected by Graver.

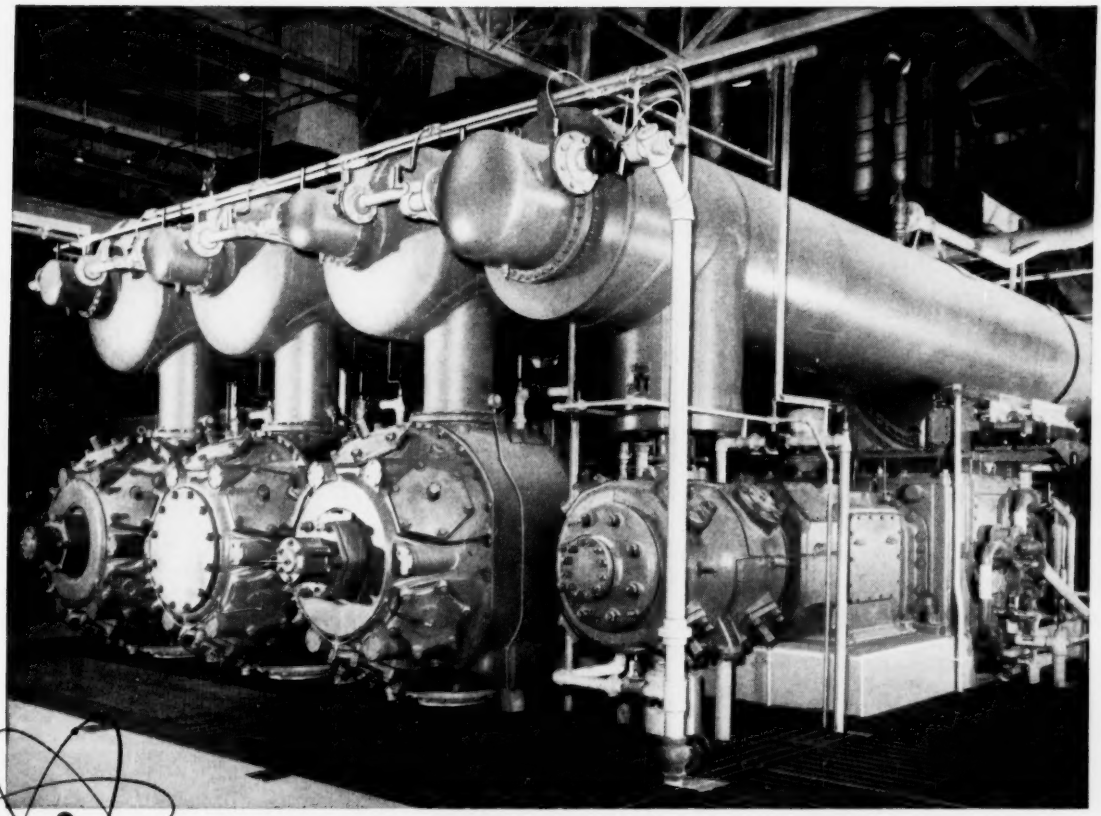
This installation is another example of Graver's capacity and century-long experience in fabricating the tankage requirements for complete plants. Similarly, Graver's nationwide facilities are frequently called upon to fabricate multiple-unit installations of processing equipment and pressure vessels for the chemical, petrochemical, petroleum and nuclear industries.

Whether your fabricating requirements are large or small, in steels or alloys, Graver's experience and versatile talents are always assurance of quality craftsmanship.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA • New York • Philadelphia
Edge Moor, Delaware • Pittsburgh • Atlanta • Detroit • Chicago
Tulsa • Sand Springs, Oklahoma • Houston • New Orleans
Los Angeles • Fontana, California • San Francisco



Two Clark CLBA-8's serve in connection with the Engineering Test Reactor designed and built by Kaiser Engineers, Oakland, Cal., for the AEC's National Reactor Testing Station at Idaho Falls, Idaho.

In ATOMIC ENERGY too, Clark Compressors Are Giving Rugged, Reliable Service

Designed to perform engineering tests on fuel elements and components of nuclear plants, the Engineering Test Reactor provides large experimental facilities which supplement research reactors already in use.

Serving a major experiment in this reactor are two Clark CLBA-8 compressors, rated at 4,500 bhp. each. With a capacity of 15 pounds per second, they are operating at a discharge pressure of 320 psig. A 13-step combination automatic and manual pressure control allows varying discharge pressures from 50 to 350 psig.

These CLBA-8's, built on the Clark-originated balanced/opposed principle, provide maximum power on less fuel in minimum space. Their field service records in a wide range of applications attest to their high efficiency, economy of operation, and low installation and maintenance costs.

The Clark encyclopedia of experience—in design, manufacture, and application—is always at your service. For complete information on all Clark balanced/opposed compressors, call your nearby Clark engineer. Or write today for the new Composite Catalog, Clark Bros. Co., 1807 Lincoln Avenue, Olean, N. Y.

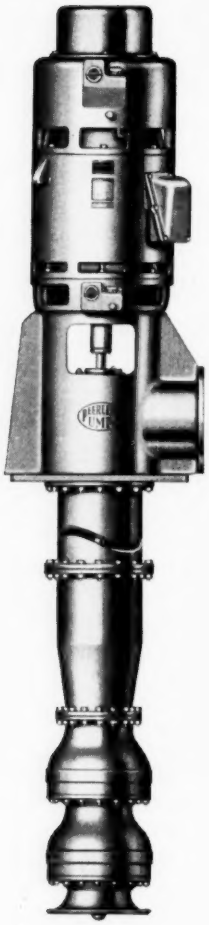
CLARK BROS. CO.

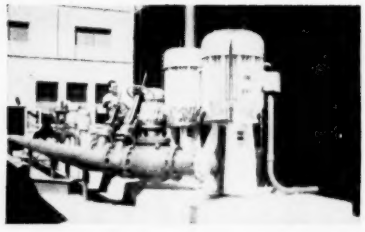
One of the Dresser Industries

Sales and service outlets in principal cities throughout the world

CLARK®

BALANCED / OPPOSED COMPRESSORS





mark of distinction

As the Northwest Indians told their story with totem poles, Peerless Pump dramatizes theirs in terms of outstanding performance. An example is the Peerless vertical industrial service pump. Versatile and economical, these pumps offer excellent head-capacity characteristics, plus other measurable advantages such as: *advanced vertical turbine design* for peak efficiency, *designed-in flexibility* for adaptation to future system requirements, *vertical pump-motor design* for maximum utilization of floor space. Available in water and process liquid handling types, the Peerless vertical industrial service pump can be applied to all installations where liquids are to be transferred from short settings.

WRITE FOR BULLETIN NO. B-505

PEERLESS PUMPS

Putting Ideas to Work

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Cleveland; Chicago; St. Louis; San Francisco; Atlanta; Plainview; Lubbock; Phoenix; Albuquerque; Los Angeles; Fresno. **Distributors in Principal Cities.** Consult your telephone directory.

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 9

Covering design, development and application data on Emery Weighing Systems for industrial applications.

EMERY LOAD CELL SIGNALS WILL WORK WITH PRACTICALLY ANY TRANSDUCER; CAN BE FED INTO A VARIETY OF INSTRUMENTS TO PERFORM PRACTICALLY ANY FUNCTION

SIGNALS CAN BE SENT TO REMOTE DISTANCES IN APPLICATIONS WHERE HAZARDOUS CONDITIONS EXIST AT THE WEIGHING SITE

The versatility of the Emery Load Cell in operating with practically any available instrumentation has made it the choice of engineers throughout industry for tank, bin and hopper weighing installations. Of particular interest is the variety of transducers with which the Emery Load Cell works effectively. These transducers convert the hydraulic input pressure from the cell to a suitable output signal, either electrical or pneumatic.

These output signals can be sent to remote distances; they can be added or subtracted; and they can be used with a tremendous variety of instrumentation to perform the various functions of indication, recording, printing or controlling. Instrument manufacturing companies such as Moore, Foxboro, Taylor, Bristol, Wiancko, Shaevitz, Wheelco, ATC and Honeywell make the equipment with which Emery Load Cells can be effectively teamed.

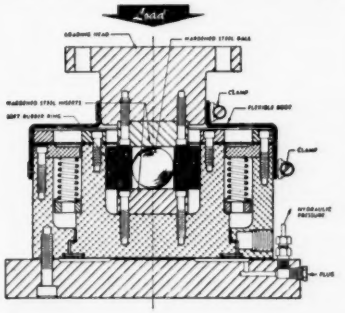
SIMPLICITY AN ADVANTAGE

The inherent simplicity of the piston-cylinder operation of the Emery Hydraulic Load Cell makes for minimized maintenance. There are no complex electronic circuits . . . no tricky electronic parts . . . no vast magnifications of almost-imperceptible electric signals to give you your results.

"ROLLING BALL" HEAD

A normal amount of expansion and crosswise movement is present in all structures such as tanks and bins. Any load cell which does not allow for this condition is improperly designed and cannot function as a versatile tank weighing unit.

The design of the Emery Load Cell incorporates a hardened steel ball located beneath the loading platform between two hardened steel inserts. (See illustration below.) This not only allows the tank or bin to expand or shift sideways, but the ball transmits the force to the cell so no deleterious operation results. As the ball rolls; the center of loading rolls on the hardened steel inserts. Thus, Emery Load Cells with the "rolling ball" head are designed to weigh tanks under normal operating conditions of tank expansion and off-center loading.



MOORE

Pneumatic Equipment

Moore Products Company, Philadelphia, Pa., is a well-known manufacturer of pneumatic control instrumentation which works effectively with Emery Load Cells.

The Moore Model 173-S Pressure Transmitter shown here converts the hydraulic output of the cell into a pneumatic signal which can operate the Moore pneumatic controllers.

MOORE PNEUMATIC CONTROLLER

Our engineers will gladly discuss the application of Moore equipment in Emery Hydraulic Systems.

Emery Cells

FOR EXPLOSION-PROOF INSTALLATIONS

The direct, self-acting combination of the Emery Cell and Indicator is inherently explosion-proof. So is the combination of Emery Cells and Moore pneumatic equipment. No electricity is required to operate them.

Where electrical transducers and instrumentation are required, we can supply them in explosion-proof cases.

Don't forget that the output signals from Emery Cells can be sent to remote distances from the weighing site to provide a measure of safety in hazardous installations.

Stay Simple . . . Buy EMERY!

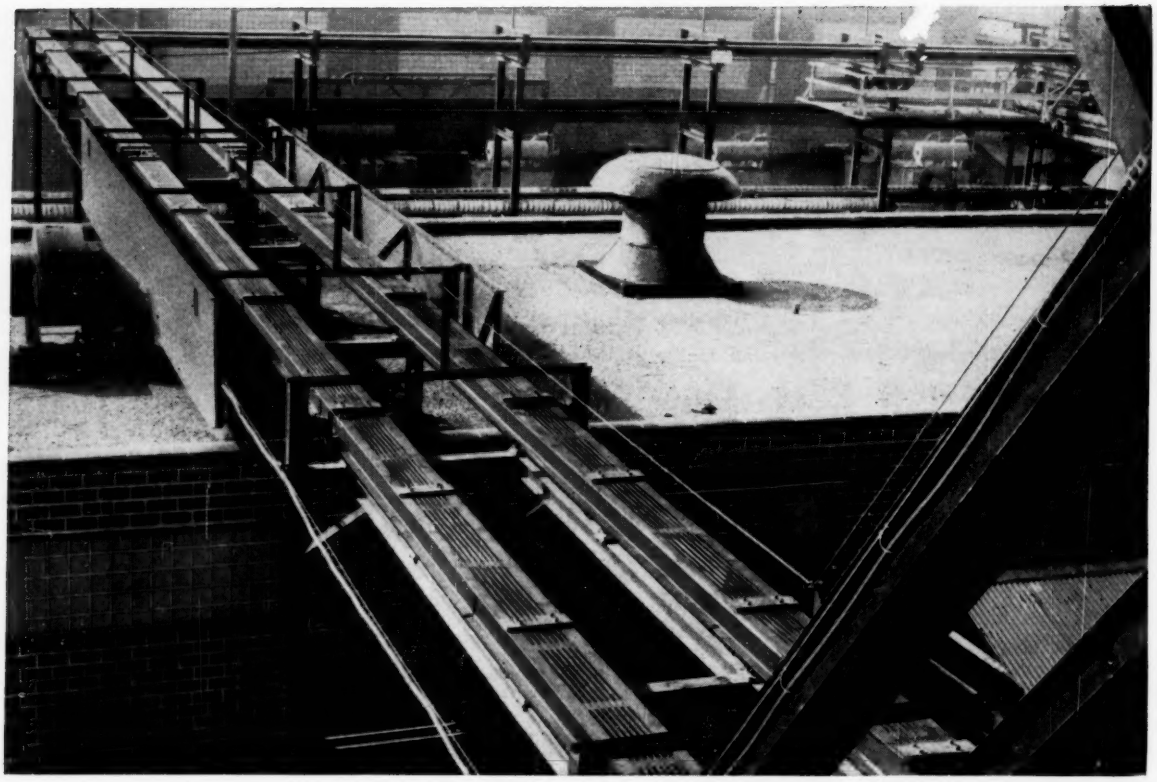
The readily-understandable, easy-to-operate, relatively maintenance-free Emery Hydraulic Weighing System is your best buy in tank weighing equipment. No complex electronic components . . . no huge magnifications of infinitesmal electrical signals.

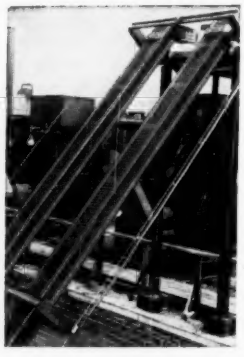
Stay simple . . . buy Emery!

THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.





▲ Insulators are installed at bottom and sides to support the bus and brace against short circuit forces.

◀ Sloping aluminum bus is unsupported between buildings of different heights. Steel frames provide rigidity.

Alcoa Aluminum Bus Serving Ethyl's Sodium-Chlorine Plant

To transmit 30,000 dc amperes at 550 volts from one rectifier station to another, at a circuit distance of 700 feet, Ethyl Corporation engineers weighed the facts, then chose lightweight, corrosion-resistant aluminum bus conductors. In considering conductors, they found three big advantages with aluminum: it cost less per foot of conductor; weighed about 50% less than copper of the same current-carrying capacity; and, as a result of this lighter weight, also reduced the cost of supporting structures for the system.

This is the second aluminum bus conductor installation by Ethyl. The performance of the first, as well as its economy, led to this second installation. The bus system serves sodium-chlorine electrolytic cells. The natural oxide film on the aluminum protects the bus from further corrosion. This protective film also improves the heat-radiating characteristics of the bus, permitting cooler operation or additional load-carrying capacity.

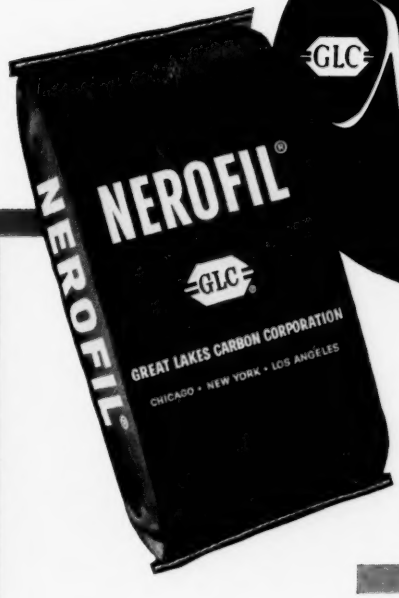
○ Savings also appeared during installation. Shielded arc consumable electrode welding, because of its flexibility and speed, was used for the welded joints. Most of the welding was done on the ground where the supporting beams were assembled, facilitating installation and increased safety.

As in many industries, the electrochemical industry has found that bus systems of Alcoa® Aluminum are the modern answer to the need for economical power distribution. For complete information about Alcoa Bus Conductors, consult your local Alcoa distributor or sales office, or write to Aluminum Company of America, 2304-F Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM
ELECTRICAL CONDUCTORS AND ACCESSORIES
ALUMINUM COMPANY OF AMERICA

Your Guide to the Best in Aluminum Value

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings



GLC Nerofil

A Family of Specially-Processed Carbon-Based Filteraids

WHERE, IN YOUR PROCESSING, CAN THESE UNIQUE MATERIALS SERVE YOU BEST?

Nerofil was developed primarily for 'difficult' filtrations involving strongly alkaline or fluorated solutions, where silica-based and cellulosic filteraids are at a disadvantage, and where no other type of filteraid has been entirely satisfactory. In this area Nerofil has proven highly successful: it is now employed in caustic and sulfur production, in textile mercerizing, in filtering ligno-sulfonates, plating solutions and others.

But Nerofil has unique properties that indicate effective service as an "all-purpose" filteraid for a wide range of industrial filtrations. That is why we ask you to review, in your own mind, processing problems which may have bothered you, to see whether Nerofil might hold real promise for your processing.

Important Special Note

The chemical and physical stability of Nerofil, its tremendous surface area and other properties, give Nerofil definite advantages as a filler for resins, cements, etc., as a catalyst carrier, in foundry use, and in other applications.

PARTICULAR PROPERTIES OF NEROFIL PRODUCTS

Fast Flowrates, Excellent Clarity

On these points, Nerofil filteraids are comparable to many grades of diatomite filteraids.

Lower Cake Density

Because of its lower cake density and high porosity, Nerofil affords filteraid savings of up to 20%.

Full Range of Grades

Six grades of Nerofil filteraids are now available to cover a wide range of process liquors.

Physical and Chemical Stability

Tests show no silicon solubility in 30 minutes in 50% sodium hydroxide at 125°F.

Compatibility with Process Liquors

Being practically pure carbon, Nerofil is unaffected by either acids or alkalies, and is readily wettable to either aqueous or non-aqueous solutions.

Combustible Filtercake

A Nerofil filtercake has a fuel value of 13,000 BTU per pound. Disposal thus presents no problem, and metal values recovery in metallurgical filtration is made easy.

Uniform Quality

Exacting quality control maintains particle size range and distribution constant in every grade.

Nerofil Department, Great Lakes Carbon Corporation
612 So. Flower Street, Los Angeles 17, California

Please send me further information on Nerofil

☐ Filtration ☐ Non-Filtration Use

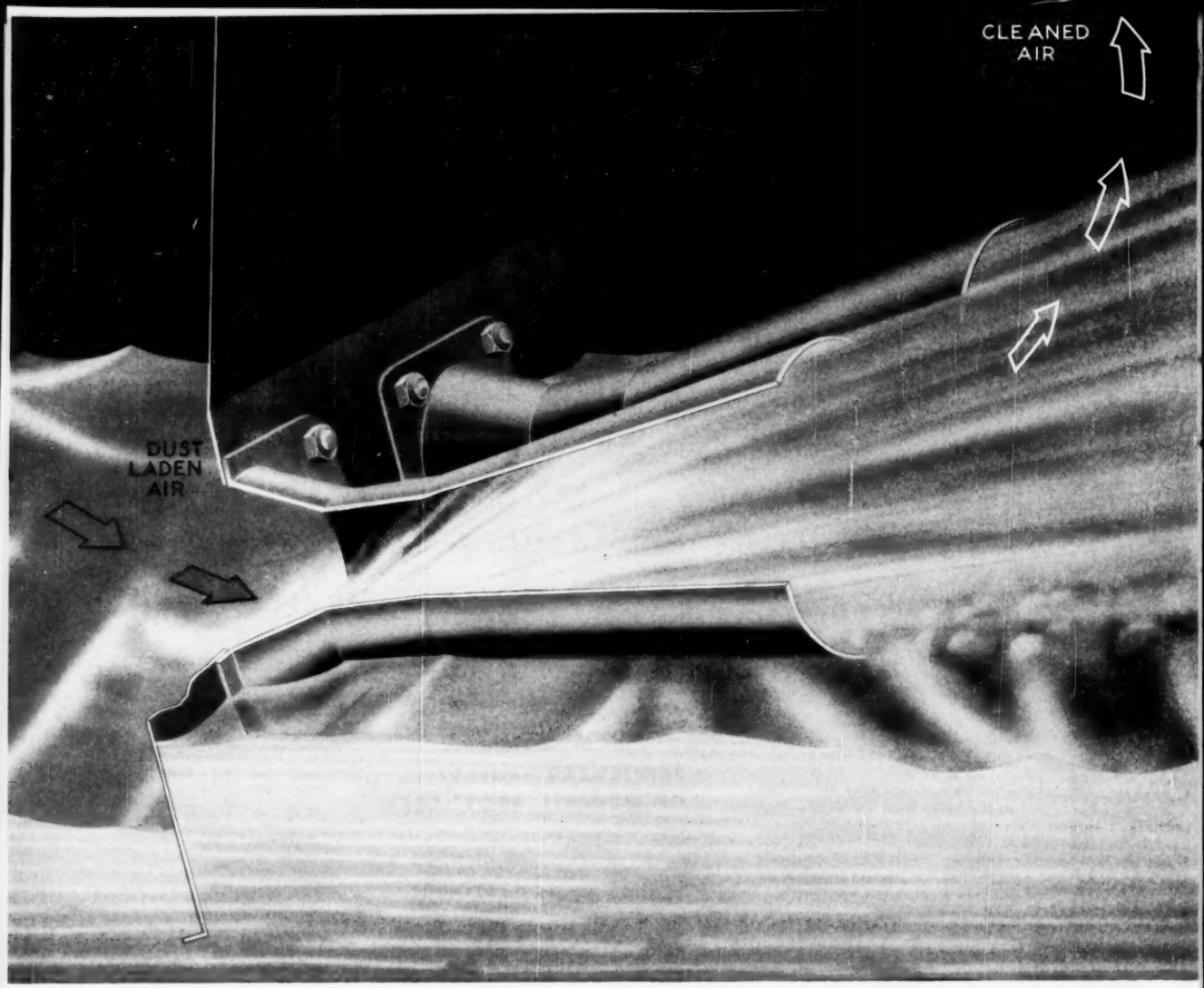
Name_____

Position_____

Company_____

Address_____

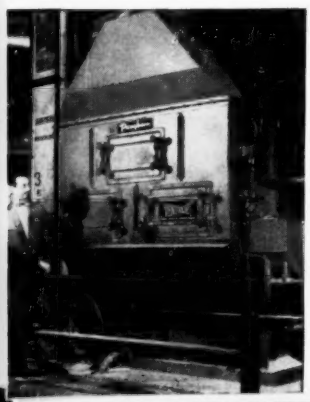
City_____ Zone____ State_____



Puts the squeeze on difficult dusts

Pangborn Ventrijet Wet Dust Collector uses exclusive venturi tubes for peak efficiency

Pangborn Ventrijet Wet Dust Collector on the job. This is just one of Pangborn's comprehensive line of wet and dry dust collectors.



That pinch-necked venturi tube is the secret behind Pangborn Ventrijet performance. As dust-laden air flows through these tubes, the constriction creates a low-pressure area which draws water into the air stream. The resulting turbulence breaks the water into particles which actually *wash* the dust from the air. The simplicity of Ventrijet design saves money in its ease of installation, its low cost of operation and maintenance.

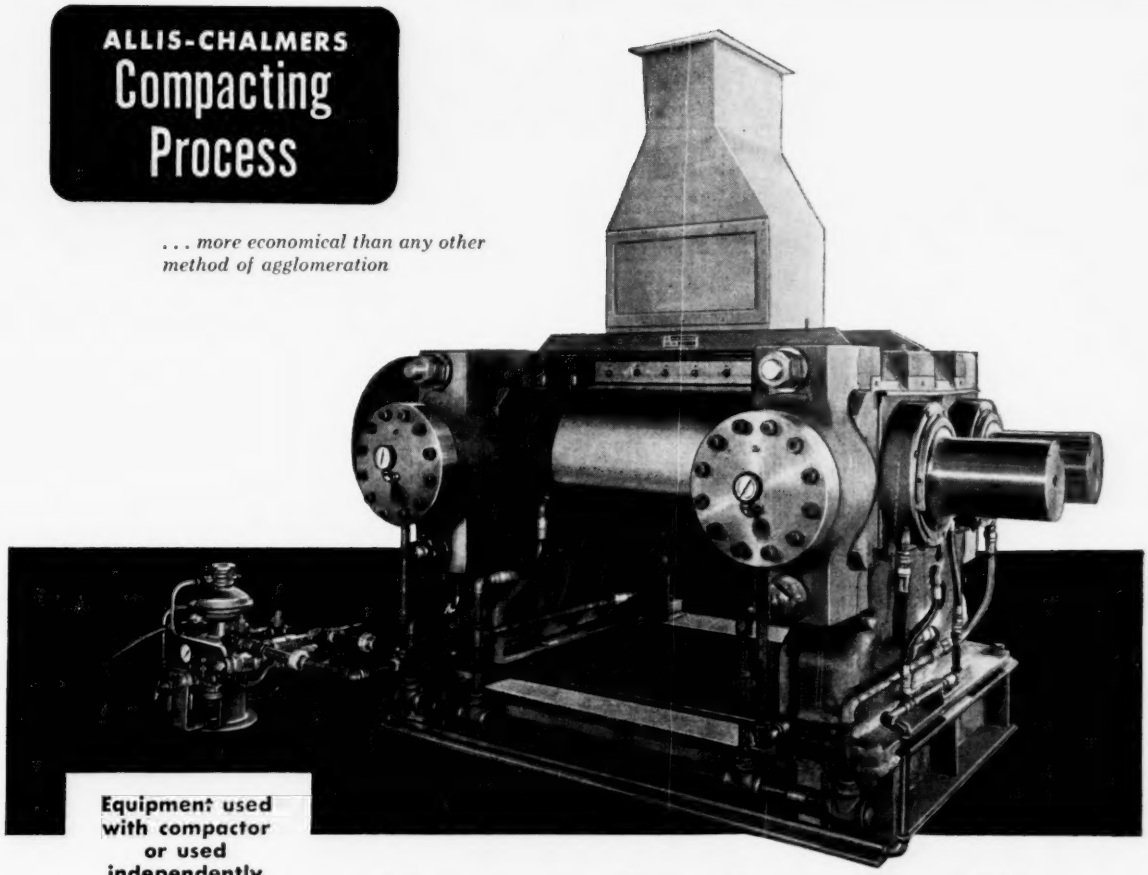
Although the Ventrijet is particularly suited to collecting hot, moist, inflammable, corrosive and obnoxious dusts, the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to put a dust collector within a plant. An efficient dust control system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This thinking is incorporated into every Pangborn proposal.

The Pangborn Engineer in your area will be glad to go to work for you. He is a dust expert *and will discuss your individual problem at no obligation. And, for more information, write for Bulletin 922 to:* Pangborn Corp., *2600 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.*

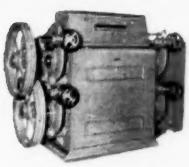
Pangborn CONTROLS **DUST**

ALLIS-CHALMERS
Compacting Process

. . . more economical than any other method of agglomeration



Equipment used with compactor or used independently



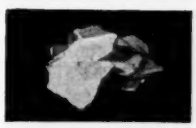
Granulating Mill

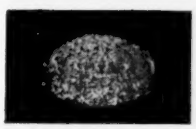
Aero-Vibe Screen

Gyratory Screen

Upgrade for Profits ...Mechanically

Precise control of *particle size, density* and *solubility factors* is now assured with the Allis-Chalmers compacting process. The heart of this efficient, completely mechanical system is this new Allis-Chalmers compacting mill.





Converts Loss into Profit

By-product material, too fine for use, from the original process, is first densified into slabs or flakes in the compacting mill. Agglomerated product is then granulated in the roller-type mill and separated in the vibrating or gyratory screen. This conversion of by-product material into a usable product changes loss into added profits.

Get Bulletin 07B8836 for the complete story. Ask your A-C representative for a copy, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

Aero-Vibe is an Allis-Chalmers trademark.

A-C ALLIS-CHALMERS

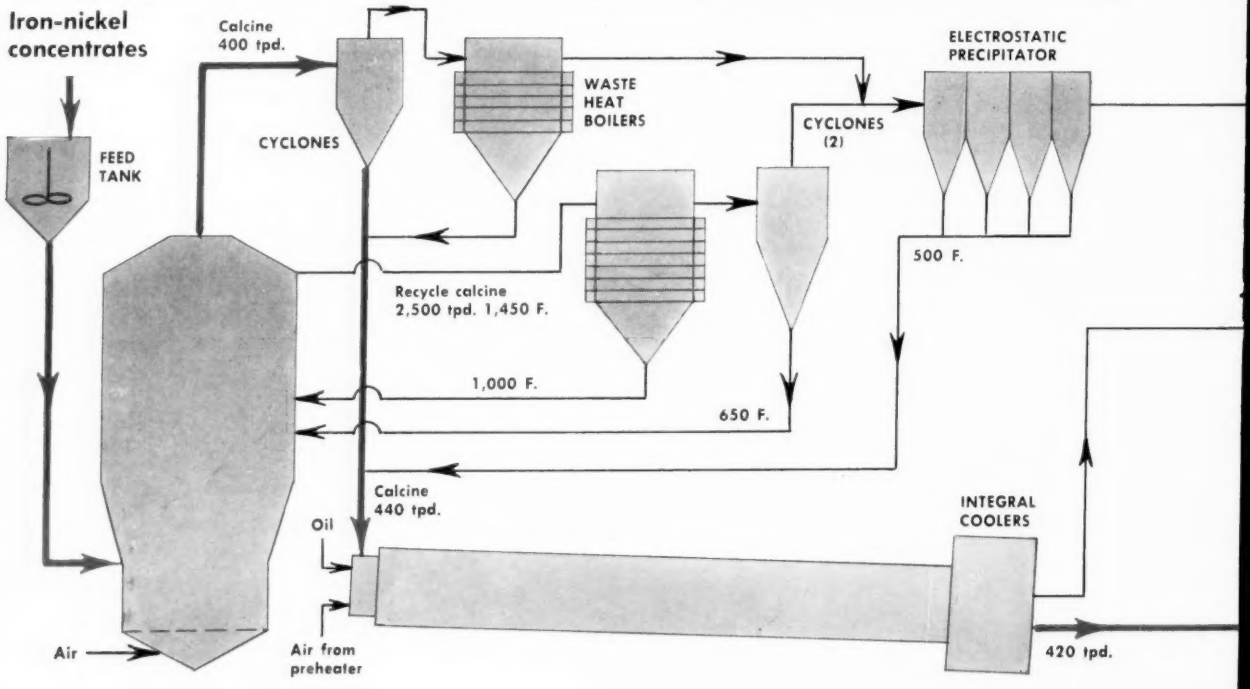
A-5582

ALLIS-CHALMERS

PRACTICE . . .

PROCESS FLOWSHEET

C. H. CHILTON



Fluid-Bed Roaster & Rotary Reduction Kiln

Optimized conditions in these two units spell profitable recovery of iron content in nickel ores.

Iron Recovery Demands Engineering Compromises

After more than a half-century of restlessly watching potentially valuable iron ore piling up on the slag heap as waste product of nickel ore processing, International Nickel Co. has commercialized a process that turns out marketable iron ore as a profitable byproduct.

Inco is now in full swing at a new $20-million plant at Copper Cliff, Ont., that processes 365,000 tons/yr. of pyrrhotite ore, yields nickel carbonate for conventional processing into nickel, plus iron ore pellets suitable for charging to open-hearth or electric furnaces. Inco's pioneering development was described by Paul Queneau, E. H. Bracken and Daniel Kelly in a paper given before the American Institute of Mining, Metallurgical and Petroleum Engineers in New York in February.

▶ **Processors' Problem**—High iron content of Sudbury nickel ores has long been a thorn in Inco's side. Since the iron-to-nickel ratio in concentrated ore is roughly 10:1, controlling factor in smelting capacity is large amount of iron slag.

Economic studies showed that in order to recover these large quantities of iron profitably: (1) Nickel content in resulting iron oxide must be less than 0.15%; (2) sulfur content of nickel concentrate must be reduced to less than 1% while producing a gas having an SO_2 content of 10% or more (for making sulfuric acid).

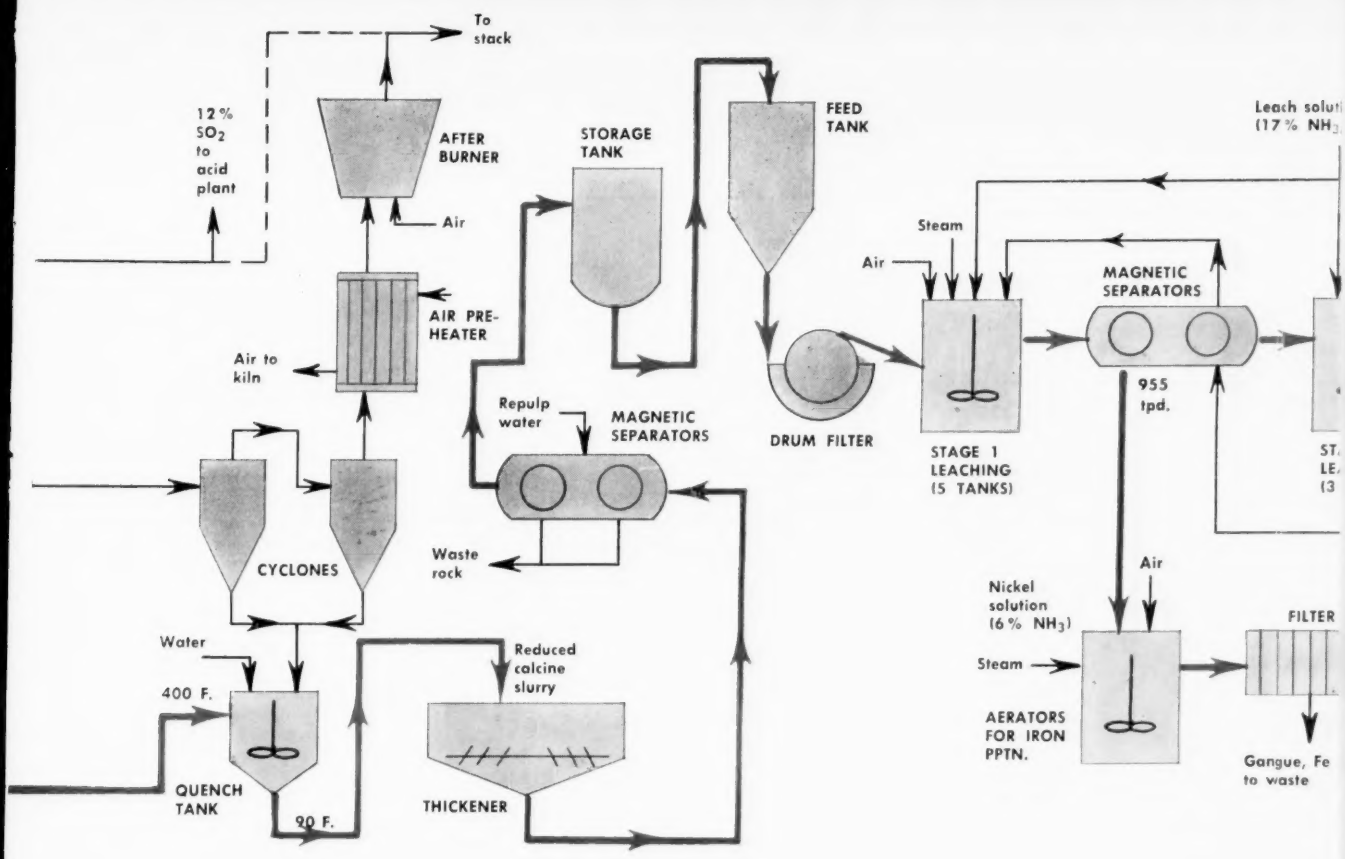
Final commercial success of a process to meet these requirements took some fancy engineering, centering on the techniques used to get optimum conditions in the fluid-bed roaster and controlled-reduction kiln.

▶ **Finally, an Answer**—This is how Inco now handles the high-iron ore:

Ore is mined and concentrated; nickel-iron concentrate is pumped as a pulp 4 mi. to the roaster-kiln building at Copper Cliff. Sulfur is eliminated by roasting the concentrate in two fluid-bed roasters.

Calcine from roasters is selectively reduced in a pair of rotary kilns. Nickel then is solubulized by atmospheric-pressure leaching in ammoniacal solution. Magnetic iron

Unfold Flowsheet



oxide is withdrawn from nickel solution in magnetic solid-liquid separators. Basic nickel carbonate is precipitated with soda ash and processed into nickel in other Inco facilities.

Iron oxide fines from magnetic separators are agglomerated into 1-in. balls on inclined pelletizing disks and fired on a traveling-grate sintering machine. Product analyzes 68% Fe, 0.003% P, 1.5% SiO_2, 0.01% S and 0.15% Ni.

▶**Process Heart and Soul**—Keys to process success are the fluid-bed roasters and rotary reduction kilns, but engineers had to compromise all along the line to pinpoint optimum operating conditions.

Dead roasting of the concentrate is simple enough. Pyrrhotite (Fe_7S_8) oxidizes to Fe_2O_3, and nickel originally in solid solution is converted to a nickel ferrite. But in fluid roasting, however, if insufficient oxygen is present, excessive quantities of magnetite (Fe_3O_4) are formed, with adverse effect on subsequent nickel reduction. In addition, high oxygen content favors roaster capacity. On the other hand, if oxygen content in exhaust gas is over 0.5%, resulting sulfate formation will impair operation of reduction kilns and electrostatic precipitators.

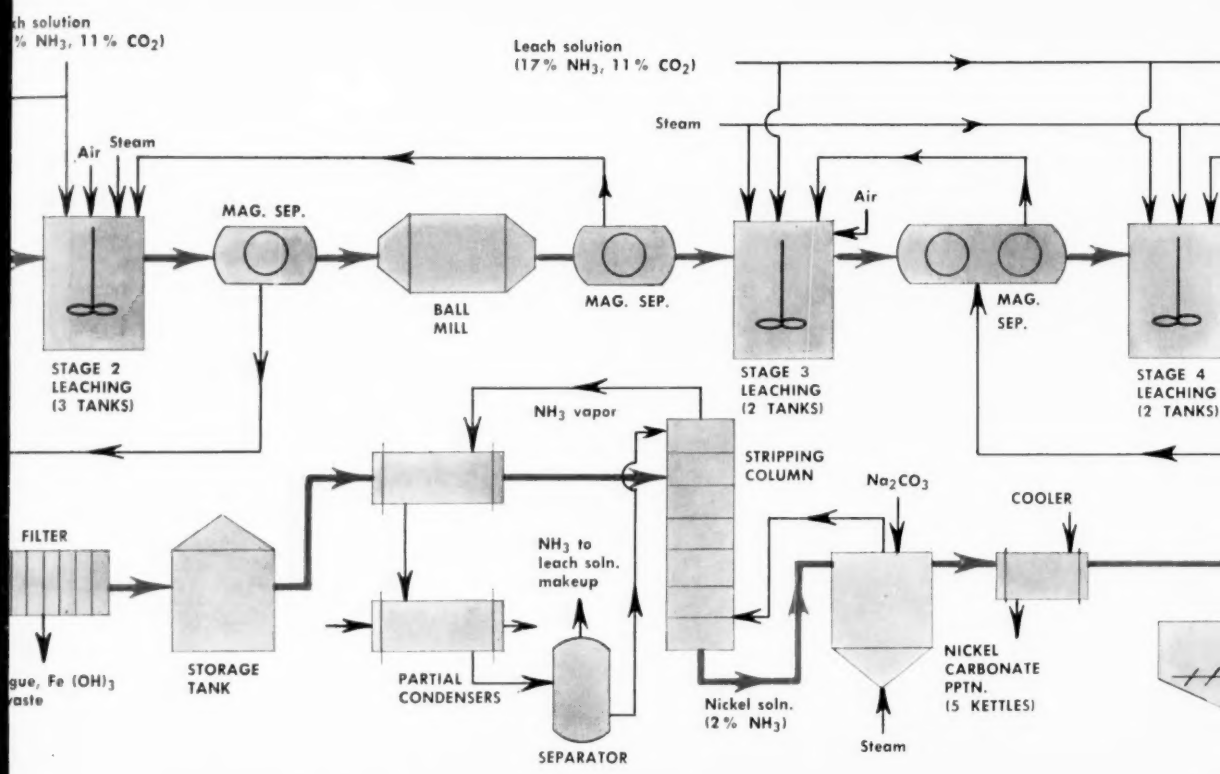
Operating temperature, too, requires compromise. Roaster capacity is favored by operation above 1,500 F., but this high temperature must be avoided because it would impair calcine activity in the reduction step. Capacity is also favored by producing a calcine with more than 0.25% sulfur, but in the leaching section this nickel sulfide dissolves at a slower rate than ferronickel.

▶**Happy Compromise**—In actual operation, roasting is done at 1,450 F. and oxygen supply is controlled so that magnetite is produced in a ratio of 1 Fe_3O_4:10 Fe_2O_3. In this way, oxygen content of outlet gas is below 0.5% while producing an active calcine.

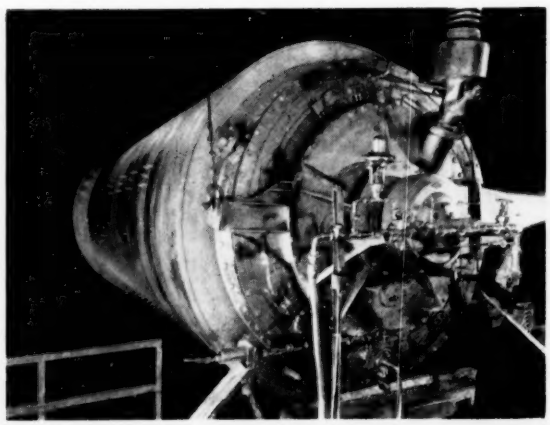
Another novel feature of the roasting step is that calcine is withdrawn from top of roaster through two different-sized outlets operating in parallel, each with its own dust-recovery system. Calcine going to reduction kiln passes out through smaller outlet, flows through small cyclones that discharge hot dust to kiln.

Circulation calcine, at a rate about five times that of production calcine, leaves roaster through larger outlet. Dust-laden gases pass through a waste-heat boiler for cooling, then through large cyclones that discharge their cooled catch back to roaster. Roasting

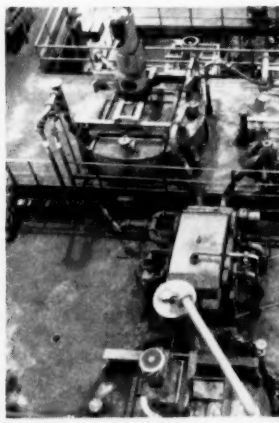
FLUID-BED ROASTER: Ir start-up oil burners and inl



ER: Inside view shows ports for nd inlet pipes for ore-slurry feed.



ROTARY REDUCTION KILN: Here at feed end are water-cooled end seal, calcine inlet and fittings for oil burner.



LEACHING SECTION: Amm Ni and magnetic separators

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cooled
sting

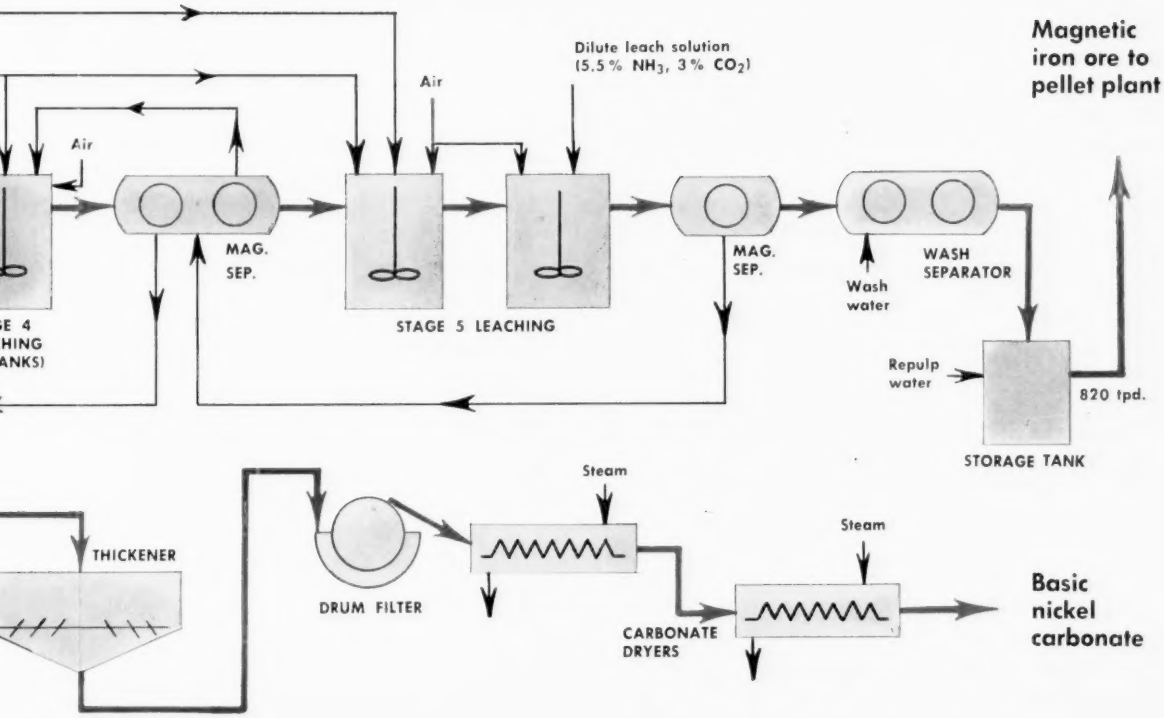
temperature can be controlled by varying circulating load, with excess heat removed as steam. Circulating calcine stream also increases residence time in roaster, permitting increased feed rate without penalizing sulfur elimination.

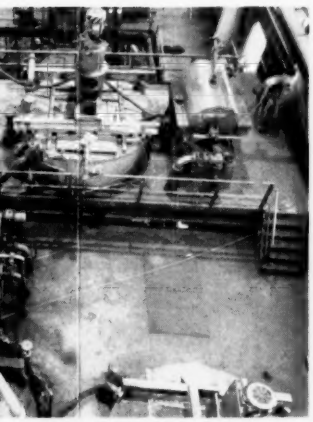
▶ **Vital Measurements** — The two roasters, of joint Inco-Lurgi design, are refractory-lined, 43 ft. high from hearth to roof. Inside diameter for 6 ft. above hearth is 22 ft., tapering out to 26 ft. Bed material is fine enough to fluidize easily but too coarse to be readily carried up shaft's wider section.

Air-flow rate for each unit is about 1,300 tons/day for 500-ton/day feed rate. Recording-controlling instrumentation on slurry and air input, together with dust return, automatically maintain bed within 25 F. of target temperature.

▶ **Reduction Follow-Up** — Product calcine is gravity-fed to a rotary gaseous reduction kiln. This operation converts nickel oxides to an ammonia-soluble metallic state.

Operation of kiln is complicated by complex equilibrium between the





Ammonia leaching tanks dissolve ators remove iron from solution.

various oxides. Since Ni^{++} can replace Fe^{++} in both Fe_3O_4 and FeO, presence of these iron oxides can prevent a considerable portion of the nickel from being reduced. And although reduction potential of kiln doesn't permit formation of pure iron, nickel can take iron into solid solution, causing further reduction of iron oxides to Fe_3O_4. Ratio of nickel to iron in this ferronickel must also be kept high to avoid trouble in leaching.

▶ **Another Compromise**—Inco engineers skirted this dilemma by designing a concurrent selective two-stage reduction system that balances excessive nickel loss in substituted magnetite against excessive iron contamination of ferronickel.

First reduction stage of kiln is at a relatively high temperature (1,600-1,650 F.) and has a strongly reducing atmosphere which limits formation of $(FeNi)_3O_4$. Most of nickel is converted to nickel-iron alloy; rest appears in (FeNi)O.

Second reduction stage is at relatively low temperature (1,200-1,300 F.), with a CO_2:CO ratio of about 2.5. Conditions are such that the iron-nickel oxide decomposes to Fe_3O_4 with release of ferronickel.

Discharge from kiln coolers is essentially magnetite, ferro-nickel and nickel-iron sulfide.

▶ **Why Rotary Kiln?**—Inco picked a rotary kiln for the reduction step in preference to a multihearth rabble furnace, says Vice President Queneau, because of more efficient gas-solids contact, greater capacity, simplicity and safety. And it won out over a fluid bed because of slow, selective reduction reaction.

Kiln is 185 ft. long, with inside diameter of 13 ft., making it the world's largest known gaseous reduction kiln. Kiln is made gas-tight by two water-cooled Lurgi end seals. Last 20 ft. of kiln is devoted to product cooling, accomplished in a peripheral air-cooled cylinder cluster; solids discharge at 400 F. Retention time is 6 hr.

▶ **Magnets Save Space**—With a magnetic iron kiln product, separation of nickel from the large volume of iron is relatively simple. Several stages of ammonia leaching bring nickel into solution, leaving behind magnetic solids that are readily separated with magnetic separators.

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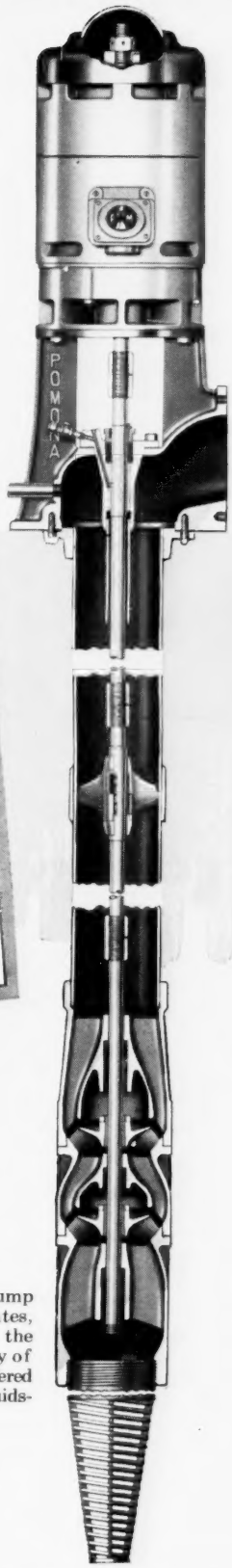

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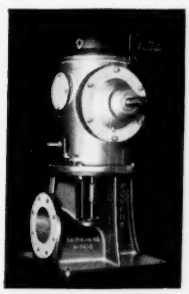

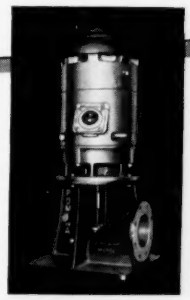

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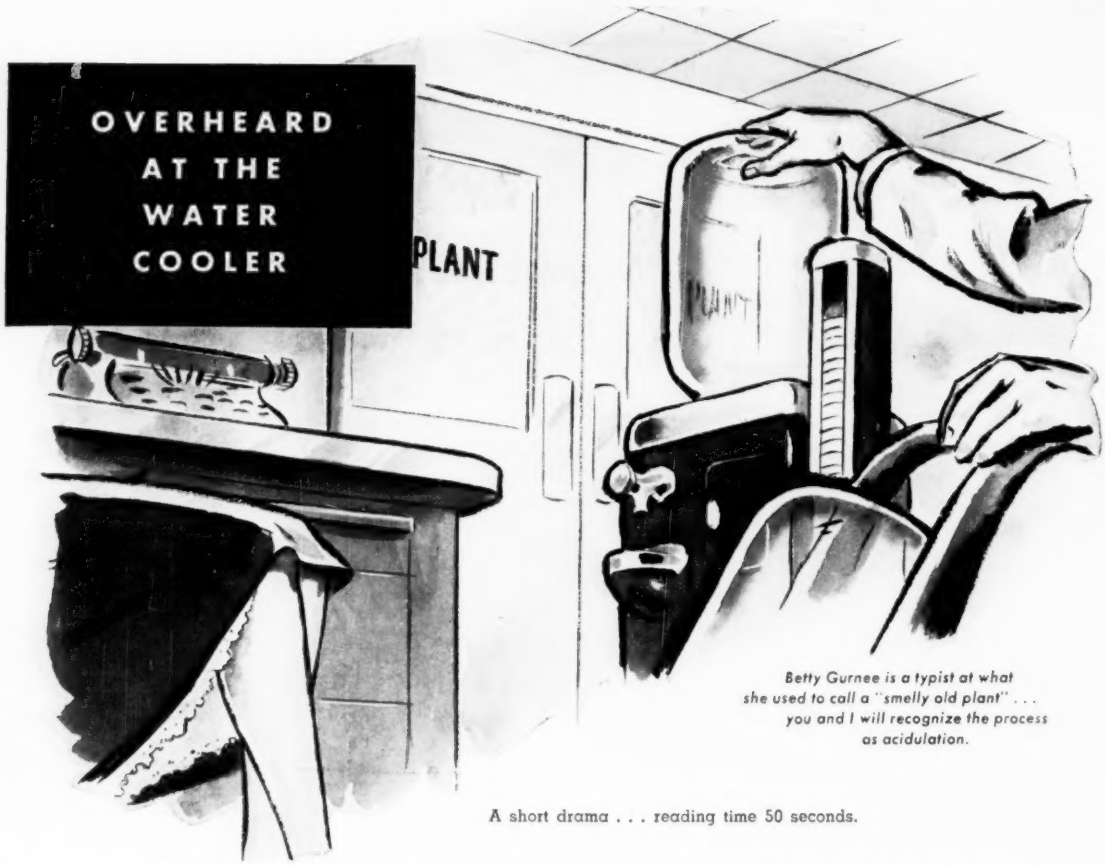

Betty Gurnee is a typist at what she used to call a "smelly old plant" . . . you and I will recognize the process as acidulation.

A short drama . . . reading time 50 seconds.

He: "Got a bunch of camels around here now? I used to fill this bottle twice a week."

Betty: "Nobody, I repeat, *nobody* used to miss that water cooler on their way out of the plant. But, since we got the new doo-dad out there . . . why, it's *almost* like a bonus."

He: (*Exit, with bottle, muttering*)

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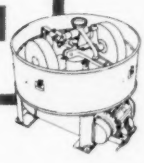

Chemical Engineering

Practice

JUNE 16, 1958

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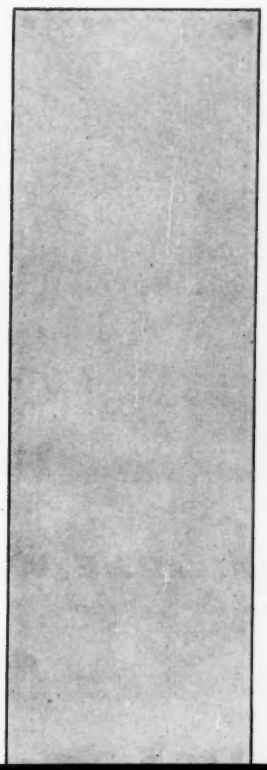

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Coming soon: Computers cut calculating time

Watch for this run-down on Monsanto research's scheme for preliminary economic evaluations. Computers are a big help in speeding up vital decisions.

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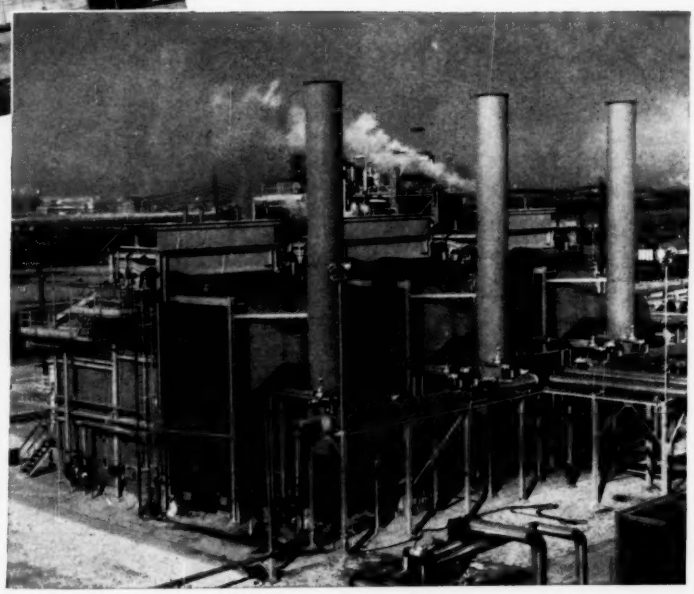

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Chemical Engineering
JUNE 16, 1958

Operation and Maintenance

This special report on Operation and Maintenance is a pioneering effort on the part of *Chemical Engineering* to fill a gap long neglected by publications serving the chemical engineer.

For some time we've noticed definite trends in this vital field of operation and maintenance. We've seen maintenance change from an unwanted stepchild to a prime part of the operating function. In fact, maintenance has become so much a part of operation that at times it's pretty hard to distinguish between them.

With the tremendous upsurge in mechanization and automation, there's been a sharp increase in investment per employee. More equipment per employee—and more expensive equipment—has really put a burden on operating and maintenance departments.

What's to be done? We're convinced these trends raise new problems for today's chemical engineer, so, we plan to expand our coverage of this vital field. In the July 28th issue, *Chemical Engineering* will inaugurate a new department devoted to Operation and Maintenance. We believe this will be a first on our part in serving this important segment of the chemical engineering profession on a regular basis.

While O & M will be primarily directed to the engineer running a plant, getting a quality product out and keeping that plant going, we're sure engineers in all phases of the process industries will find this new department a valuable addition to *Chemical Engineering*.

On the following pages, our authors will introduce some of the subjects and areas this department will serve. Whether you're in design, production, maintenance or research, we're certain this report is essential reading.

Meet Your O&M Report Authors

Technical Service Groups..p. 144 Contract Maintenance ....p. 146 Leasing .....p. 150

R. D. Barnard worked for Dow Chemical's research department until 1952. Most of the work there concerned chlorination of hydrocarbons and Barnard got into operation problems in production plants. As a result, work from other plants was soon funneled to the group, until finally it was tabbed as a production service group. Barnard earned his degree in chemistry from the University of Wyoming.

Raphael Katzen is a consultant in Cincinnati. He set up Raphael Katzen Associates International, Inc., in 1956, offering services in Canada and Latin America. But his own practice as a consultant dates from 1953 when he took on projects in the organic chemicals, petrochemicals, pulp and paper, low temperature technology and atomic energy fields. Katzen obtained his doctorate in chemical engineering from Brooklyn Poly.

J. Ernest Nachod is manager of chemical plant sales for Air Products, Inc., Allentown, Pa. Before he took on that post in 1956, he spent five years as general manager of DuraTred Co., Chicago, Ill. Earlier associations included Hercules Powder's engineering department and DuPont's ammonia department. Nachod earned his B. S. in chemical engineering from Penn State. Later, he attended UC's School of Jurisprudence.

Dryers .....p. 154 Filters .....p. 160 Thickeners and Clarifiers..p. 168

Paul Y. McCormick joined DuPont's engineering department in 1955. He specializes in drying and related solids processing activities. Earlier in his career, he spent some nine years in the food and drug industry—seven of which were with the Nestle Co., in Fulton, N. Y. McCormick is a licensed professional engineer in the State of New York. He earned his bachelor's degree in chemical engineering from Syracuse University, in 1944.

Glen G. Reed is director of the filtration technical division of Dorr-Oliver Inc. He first joined the former Oliver United Filters Inc. in 1947 as a sales engineer. Later, he worked in filtration development and finally got into sales. When Dorr and Oliver merged in 1955, he was named manager of filtration sales for the entire United States. A year later he became manager of sales services, which involved expansive business responsibilities.

Glenn O. Wilson is director of the industrial technical division of Dorr-Oliver Inc. He first joined Dorr while still in college. Subsequent positions included work in design and industrial sales. In 1945, after handling the firm's Northwest marketing activities for 17 years, Wilson was named assistant manager of the 11-state Western Industrial division. In 1948, he became manager and by 1954 jurisdiction included all of North America.

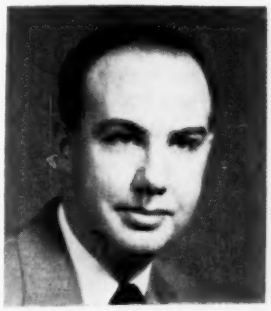
Pumps ..... p. 178

R. R. Rhodes has spent most of his career working with centrifugal pumps. He developed Worthington Corp.'s mechanical seal for Worthite pumps. What's more, he has done extensive corrosion work with Worthite (Worthington's super stainless steel) and other stainless steels. At present, he's assistant manager of sales for the firm's standard pump division, and editor of the firm's corrosion publication, the Worthite News.

Materials Handling Equipment ..... p. 164

Harrison N. Howe has been a materials handling consultant in the engineering service division of DuPont's engineering department, since 1956. Before that time, he was associated with Anheuser-Busch Inc., in St. Louis, in the materials handling and packaging phases of bottling plant operation. During the Korean War, he served aboard the Navy's USS Philippine Sea. Howe is a mechanical engineering graduate of the University of Missouri and is a registered professional engineer.

Thomas O. Menary has been a materials handling consultant for the past three years in DuPont's engineering service division, engineering department. From 1951 until 1955, he was associated with Fairbanks, Morse & Co. at their largest plant in Beloit, Wis. He held the post of supervisor of plant layout. Before that time, he was an engineer in the Midwest division of California Packing Corp. He is a mechanical engineering graduate of Iowa State College, class of 1949.



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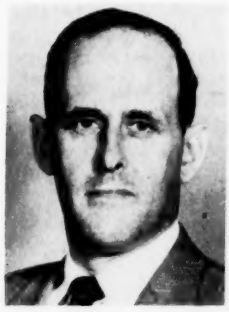


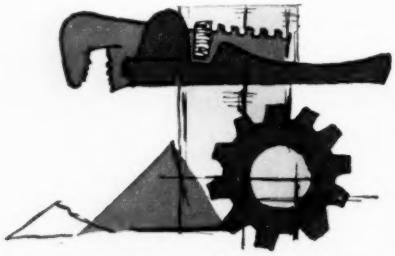
Ian MacLeod is a senior service engineer with a mechanical engineering group, in DuPont's engineering service division. He was educated in England, where he passed the examination for the Institute of Production Engineers. Previous associations have included Sharples Corp., and Premier Mill Corp.

Peter T. Moroz is a consultant supervisor in the engineering service division of DuPont's engineering department. He specializes in fluid mechanics, agitation (process and mechanical), pumps, compressors and polymer processing. For the last 18 years with DuPont, he has had direct contact with equipment problems in chemical processing.

Richard P. Leedom has worked for DuPont's engineering department since 1950. For the past five years, he has worked with the equipment specialists group developing agitator specifications and designing special machine components. Earlier in his career, he worked for Atlantic Refining Co.

H. W. Dutton, Jr., joined DuPont in 1953 to work in the engineering service division. He designed agitators for practically all DuPont processes at one time or another. He has also done consulting work on heat transfer, pumps, and size reduction. Earlier in his career, he worked for Procter & Gamble in process engineering.

Industry Trends in Operation



Technical Service Groups

These groups can be a great help to the production department in trouble-shooting, process studies, capacity increases, etc.

R. D. BARNARD, Supervisor, Production Technical Service, Dow Chemical Co., Pittsburg, Calif.

Today, chemical plants are highly complex units integrated with a host of complimentary facilities and usually arranged for continuous operation. To design, operate and improve these plants, a high level of applied science and technology is required.

Technical assistance is required for smooth operation and improvement in a successful plant. This technical service is supplied in a variety of ways.

Why Use Separate Groups?

People in a direct line organization—production managers, plant superintendents, maintenance supervisors—are usually competent technical men. However they're so tied up with personnel supervision, planning, maintenance and other administrative functions that they have little time for any other aspects. They're selected because they have those particular skills that are successful in a line organization.

It seems production men are rare that have both the time and technical background necessary to provide the information they need. They simply have to look for assistance to provide it.

Research departments are very often used to supply this technical assistance if they're on or near a plant site. This appears to be a convenient arrangement. Research departments have the most highly developed groups of technical people. But, this arrangement is bubbling with difficulties. Why? Let's look at the organizational structure.

Lines of official organization and authority progress up the line organization, cross at the research director and plant manager level and go back down to laboratory personnel.

Trouble-shooting is a high-priority job. A plant that isn't running properly can be a heavy expense. This creates a situation where research personnel continually leave their own work to assist the production department. Research suffers. Because communication lines are long and skills scattered, this type of organization hardly gives the most effective service.

Consultants outside your company can be employed at times. Caliber of technical competence available from consulting firms is high in some fields. Finding the right people for the particular job is probably the most difficult step in acquiring technical assistance by this method.

Consultants are usually employed to solve severe production problems, provide design information on things such as an unusual materials handling system and to solve problems outside the experience of the operating and engineering departments. They're seldom used for any sustained technical assistance.

Enter the Tech Service Group

There is an organization type that sits at the opposite end of the pole than that mentioned above. In this case, one or more chemical engineers or chemists are included along with plant personnel. Their duty is to provide technical assistance while reporting to the plant superintendent.

To warrant this arrangement, a rather large production unit is required in terms of value of the product. It has the advantage of sustained technical effort in process operation and improvement.

In connection with a research department, coverage can be very complete. Unfortunately, coordination between production units isn't the best under this system. Close communication between separate plants just isn't the normal thing.

Where Does It Fit In?

Technical service groups are staff groups within a line organization. The group reports to a production manager while being directly responsible to the plant superintendent. Lines of communication, authority and responsibility are short and clear.

These groups are powerful tools to improve processes, cut costs and provide a liaison between production, research and engineering.

Only a small percentage of the total employment of a plant is made up of technical service people. They should be housed in the same building with the research department. Library, analytical laboratory, glass-blower and all other special services should be available.

and Maintenance

Support of the research organization is vital to their proper functioning. Direct services and indirect help in the form of ideas or suggestions from the specialized groups within research departments are invaluable. Sometimes, the research department can be called upon to study particular problems when the tech service group doesn't have the time.

Personnel: High-Caliber and Experienced

Technical service people should be chemical engineers or chemists with a lot of chemical engineering experience. Types of skills, knowledge and temperament required of these people are usually found in research or research engineering departments.

Innate curiosity, problem-solving ability and a general dissatisfaction with things as they are, constitute essential personality characteristics. Since these people are continually up to their necks in trouble, one crisis after another, they also need a philosophical outlook. Otherwise they'd be nervous wrecks.

Considerable experience in plant operation is necessary to develop a nose for trouble. To be fully effective, a member of a tech service group should know several plants and processes intimately. He should be able to spot reasons for trouble fast, the ultimate before it happens. This requires a good knowledge of physical phenomena (heat and mass transfer, fluid flow, distillation, filtration, etc.), chemical reaction phenomena and the application of these principles in unit processes.

An Example of How They Work

Here's a classic example of a technical service group's relation to a new product:

Research discovers a new process or product. Economic evaluation shows it's a profitable development.

Technical service starts to follow the development as soon as this discovery is of interest as a process that might be built. In some cases, tech service will pilot plant the process. In any event, it's the group's responsibility to OK the process from an operational standpoint and to see that all necessary data for good plant design are obtained.

Technical service and a representative from production follow equipment design done by the engineering department. They offer suggestions based on experience with the pilot unit.

A formal report contains all delineable results. However, there's always a lot of information of a more subtle nature that's never included in a report. This comes out during process design. Close liaison prevents mistakes that otherwise would be included in the final plant design.

Some member of the group devotes at least part time during construction to help a representative from the engineering department with inspection. This is primarily to familiarize himself with the physical plant and to help eliminate mistakes that creep in.

Starting instructions are written including a simplified flowsheet and chemical description for operator training. This is reviewed with the plant superintendent, who, if possible, has been closely following or even participating in the pilot plant work. Assistance is given to the superintendent in training operators.

Technical service is on every shift when the new plant goes on the line until it's operating satisfactorily and they'll continue to work closely with the superintendent until all the "kinks" are worked out.

This is always a trying time—even in the best-engineered plants. Systems with hundreds of valves, instrument points, heaters, coolers and other equipment can hardly be expected to be free of bugs from the start.

Interactions can so confuse things that it's difficult to pinpoint primary troubles. Improperly cut gaskets or rags in critical lines have caused lots of lost sleep in the chemical industry.

From this point on, the technical service group assists the superintendent in trouble-shooting, process study, improving material efficiencies and increasing capacity.

Processes Can Be Coordinated

A dividend that accrues from this type of organization is in coordinating plants in technically subtle ways to the great advantage of one or both plants. This is possible only if processes of two or more plants concerned are intimately known and understood.

An example of this was in the elimination of a process step to remove iron in the production of 50% caustic soda. Iron specification on 50% caustic is 10 parts/million, 100% caustic basis. Removal of iron by treatment with strontium sulfate had been standard practice. New uses of caustic developed where strontium was objectionable so this method had to be discontinued. Alternate treating methods are available but capital and operating expenses involved are high.

Members of the technical service group studied both the electrolytic cell department and the caustic evaporation department and suggested suitable monitoring, segregation of cell effluent and careful operation. Specifications could then be met without treatment. This proved true and is now standard practice.

Technical service groups are called on to give assistance on all sorts of problems; from very small ones to those requiring several years time.

Personnel must work closely with operating departments. With experience, both groups come to appreciate and understand each other's attitudes and approaches to problems. It's only after a harmonious relation is established that the best job can be done.

INDUSTRY TRENDS IN O & M

Rise of Contract Maintenance

What it is . . . what types are available . . . how much it costs . . . why to use it . . . how it fits into operations.

RAPHAEL KATZEN, Consulting Chemical Engineer, Cincinnati, Ohio

Slowly but surely, the role and scope of maintenance in the modern process plant is changing. We're finding that maintenance is becoming indistinguishable from operation. Into this changing picture has come the rise of contract maintenance. Here, specialized organizations take over certain maintenance functions on a contract basis.

What Is Contract Maintenance?

Contract maintenance is a service offered by an independent contractor to an operating plant or company. This service will provide any or all of the key items required for specific maintenance programs, namely: labor, supervision, materials, tools, rental equipment and sometimes even the actual scheduling and planning of the maintenance operation.

Contract maintenance is sometimes used in the petroleum industry for the "turn-around" that generally requires two weeks of every operating year. In this type of maintenance, the contractor moves in with a crew that proceeds on a planned schedule to: dismantle equipment and piping; clean and make necessary repairs and replacements; reassemble; test; and prepare for operation.

Other types of contracted maintenance can involve:

- Special installations such as addition of replacement or auxiliary parts while dismantling, cleaning and repairing a unit.
- Jobs where certain items of equipment are quickly dismantled and put back into operating condition without shutting the plant down. This requires particular skill in providing temporary bypasses, hook-up of portable spare equipment items and other facilities so that the maintenance won't interfere with production.

Many Types Available

Maintenance can fit into several general categories:

- Turn-around.
- Planned special maintenance.
- Emergency maintenance under operating conditions.

Other classifications of contract maintenance can range from chemical cleaning and descaling to special work on electrical facilities, insulation repairs, painting and resin coating.

In some cases, the services are so specialized that a particular contractor can offer a complete package involving his own labor and portable equipment, and then execute the entire operation without using the owner's facilities.

Dowell service for cleaning and descaling boilers and process equipment is a good example of this. Here, stations operated by Dowell or its lessees prepare treating solutions that are transported to the job site in special trucks. Highly trained and skilled personnel, already familiar with the plant operation and physical set-up, arrange to cut out the piece of equipment to be cleaned. They then hook up their portable truck-borne equipment, pump treating solution through the equipment, make tests to insure complete cleanliness, inspect the equipment, put it back into the line and then pack up and leave.

Such service is available either on a regularly scheduled basis or for emergency needs alone.

Other special services are available from contractors to maintain highly complex instrumentation systems, water-treating systems and waste-disposal operations.

However, the most advanced and complex type of contract maintenance is the refinery turn-around mentioned earlier. This type of contract maintenance is particularly applicable to plants running continuously that allow about a two-week period to shut down major units for inspection, cleaning, replacement, repair and testing.

Once the operations in a plant or refinery are well established, a detailed schedule is set up for the turn-around maintenance. This is reviewed by the company management and engineers with the contractor. Plans are made for the specific types and number of skilled craftsmen; labor; tools; rental equipment such as cranes, hoists, trucks and bolting machines; and special materials such as gaskets, bolts, nuts and cleaning compounds.

Highly developed logistical skill is necessary in placing men, materials, tools and equipment in the right place at the right time without creating pandemonium or waste motion and effort, with people getting in each other's way.

A major portion of the engineering supervision is supplied by the operating company in this type of turn-around maintenance. But, the contractor is expected to bring in skilled foremen and construction supervisors to direct his own men.

How Is the Bill Paid?

Naturally, the question comes up as to how you figure the cost of contract maintenance. In only a few cases, can you estimate the project accurately enough for the contractor to set a lump sum price. This can be done in fairly routine jobs such as the cleaning of boilers and process equipment that are periodically handled on the same basis so the equipment history gives a fairly reliable cost indication.

On the other hand, such work as a refinery turn-around must of necessity allow for unforeseen problems that develop in the cleaning and inspection of equipment. Here, the contractor usually has unit rates for particular types of work and material. Billing is based on a detailed record of the labor and materials involved.

In most cases, the contractor's profit is set in terms of a fixed fee based on the overall scope of the work. However, the hourly rates for labor may include a profit margin as well as overhead and fringe benefits and there may even be a slight mark-up on materials to give some additional profit to the contractor.

Whether a contract is based on cost-plus-fixed-fee or a cost-plus-percentage, accurate control can be maintained only by having detailed requisitions and records of time and material. In large maintenance jobs, preliminary estimates are developed by the user's engineers and are checked by the contractor. Well-detailed cost control systems can provide for change orders and extras approved by the user's engineer or superintendent. Generally, this provides enough control to hold costs in line and justify any extra costs that are incurred.

Many Reasons for Its Use

In the past, each plant built up its own maintenance facilities, personnel and material stock so that it could handle an emergency of any type. With the growing size and complexity of modern chemical, petrochemical and petroleum plants, the cost of building up facilities, organization and material stock gets out of proportion to the value received.

For example, the annual turn-around in a large refinery may require several hundred specialized workmen, dozens of items of special equipment and literally thousands of extra tools. If a plant is staffed with this number of maintenance personnel, full and effective use of them can not be made the year round.

With tools and equipment, there's the same problem of having most of the items idle 90% of the time. Result: heavy fixed charges and maintenance costs on the equipment and tools themselves.

Contractors supply labor, tools, equipment and materials. These are effectively scheduled to fit in with other contract maintenance they do as well as general construction work. Thus, manpower is moved from a job just being finished to the one currently contracted. Similarly, tools, rental equipment and materials are moved from a recently completed job to the new one under contract. Maximum effective use is made of specialized personnel and equipment.

The reason for contract maintenance can be summed up by the best measuring stick: dollar costs. In an operating plant, the only real measure is the minimum cost to perform an operation. Contract maintenance is justified only when the total cost is less than if you used your own personnel, tools, materials and rented equipment.

Use caution in figuring gross costs. For example: special tools and equipment when purchased must be capitalized and carried on the books for a long period of time. Only a moderate rate of depreciation is allowed under the current tax law. On the other hand, if equipment is rented, it can be expensed directly and there isn't any capital charge involved.

Watch similar items of cost with labor. If more people are added to a payroll on a permanent basis, plant overhead and the costs of auxiliary services and facilities are increased. Contractors cover all these costs in the total rate charged for labor and all of this can be treated as an expense.

Operations Are a Factor

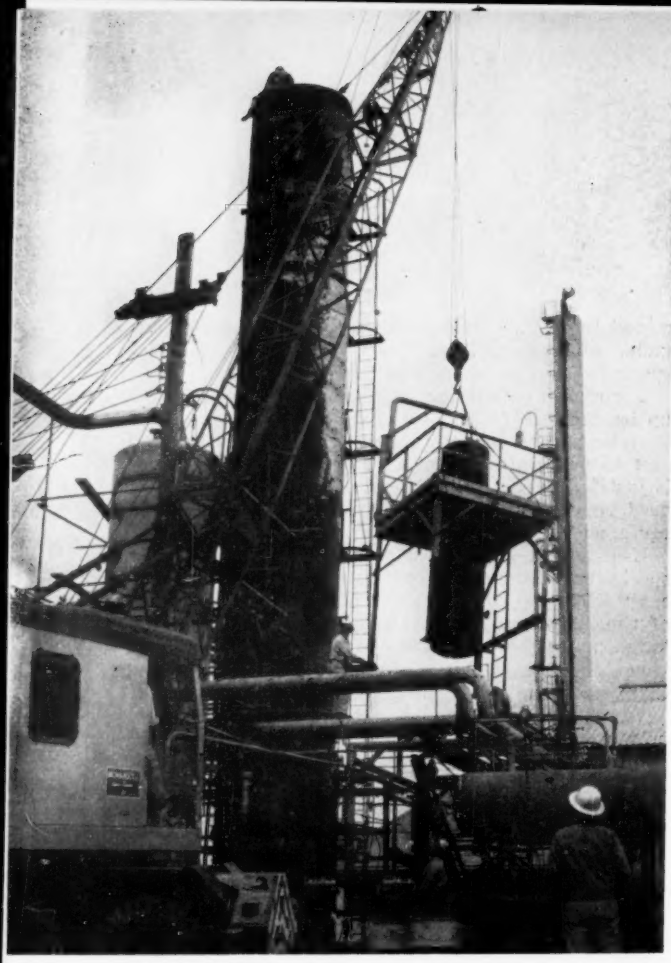
How does contract maintenance fit into the operational picture? Maintenance must be carried out both when a plant is in operation and in periods when the plant is shut down.

Fairly routine operations such as lubrication, pump and valve packing and gage inspection are carried out on a regular basis by permanent maintenance employees on the plant payroll. This can be effectively done at minimum cost by setting up a year-round schedule of routine maintenance work.

On the other hand, specialized maintenance, carried out when an entire plant is shut down, or in critical emergencies when certain units are shut down for major work (even though the overall plant is still operating), can be done by a contractor without getting into operational problems.

When equipment is shut down for maintenance while the rest of the plant is in operation, a contractor must know of the problems and hazards involved in carrying out mechanical maintenance in an operating plant. This is especially so in chemical plants where fire and health hazards are often present. Only by a thorough education of the contractor, can there be any confidence that no major damage will be done and operating personnel won't be endangered by the maintenance operation.

Even when there's a complete shut down, special precautions are necessary since equipment and pipelines may not be thoroughly cleared of process streams. Here too, engineers, supervisors, management and even operators must work closely with the contractor as equipment is opened and dismantled to make sure that it is properly cleared and cleaned of hazardous materials.



CONTRACTORS can move in with a crew to dismantle, clean, replace and reassemble equipment. (Brown and Root, Inc.)

When procedures are established and experience is gained with contractors in specialized maintenance work, the contractor is regarded as an auxiliary addition to the plant staff on a short-term basis. With familiarity developed, the contractor and his personnel can enter a plant, execute required maintenance rapidly, put equipment into operating condition and leave the premises in good shape so that operators can take over again with minimum loss of time.

Look At the Advantages

• The major advantage of contract maintenance is reduced cost of maintenance work. This is done by minimizing the number of permanent maintenance personnel on the payroll.

• No need of owning surplus tools or equipment beyond those required for routine maintenance. Specialized equipment and extra tools required can be brought in by the contractor for his specific maintenance contract.

• Maintenance in a highly concentrated form is carried out in the minimum time possible instead of having periodic interruptions to operations every few weeks or months. An entire plant can be kept in a balanced operating state for 50 weeks out of the year and then the entire operation can be shut down at one time for over-all maintenance. The net loss of time and production and the net minimum cost of maintenance are achieved.

• Operating and routine maintenance personnel in the plant aren't taken from their major duties into emergency maintenance operations. When personnel generally used for operations or routine maintenance are put into emergency or specialized work, their routine work suffers.

This is particularly true when major maintenance work must be done without shutting the plant down. At this time, operating and routine maintenance personnel must stay at their regular work and, in fact, be on their toes more than ever to make sure any temporary measures taken don't interfere with operations. If management tries to do this with their own personnel, they'll find men spread a little too thin.

Disadvantages too . . .

Most obvious of the disadvantages occurs when a contractor isn't familiar with plant operations and takes some time to get organized, train his personnel and get the work done. Particularly in familiarizing himself in the plant, a contractor can appear awkward and inefficient as men are brought into the plant who aren't acquainted with the equipment or layout.

Next, there's always the direct and immediate problem of labor relations. Whether or not the plant and contractor's personnel are unionized, the problem is with us. First of all, maintenance men on the payroll will probably look at all maintenance work as coming under their jurisdiction.

Natural tendency on their part is to latch on to work and then try to stretch it out to make sure there's enough work through the year. Of course, there's also the other inclination, to ask for more personnel on the maintenance staff so that they can handle any emergency.

When contractor's men come into a plant, there can be a violent clash of interests so advise your own maintenance personnel of the nature and scope of work being done.

When unionized groups are involved, the problem may be an even greater one. For example, plant personnel could be in a C.I.O., industry type union, while the contractor's personnel may be A.F.L. craft workers. Similar problems occur in construction work where, at times, one union won't accept materials or work handled by craftsmen from another union.

Another obvious disadvantage is the special case of emergency maintenance where work has to be done without shutting a plant down. Here, job familiarity with operations is of the utmost importance. It isn't too easy to isolate a defective unit, hook-up a spare replacement, do the repair work and then re-install the old unit in the line. If they don't understand what's going on, they're bound to interfere with production.

Many companies feel that since the operating and maintenance personnel on the staff are more familiar with operations they can get the work done with less chance of difficulties and interference with production.

Future Looks Bright

Maintenance is essential for continued efficient plant operation. If this maintenance operation is separated from actual production, specialized personnel and supervision required for maintenance can be developed to supplement a highly skilled operating staff.

Contractors, with such special skills in supervision, labor, equipment and methods, offer highly specialized service. This yields economies in turn-around and emergency type maintenance and results in minimum down-time and interference with production.

Several large engineering construction companies such as Procon and Catalytic are already in the field and have the special skills to service the chemical process industries. Other and smaller contractors in chemical and petroleum areas are offering these same services to plants throughout the U. S.

One indication of the trend, although it goes back over many years, is the development of various specialized companies for particular types of maintenance and service work. Numbers and types of such specialized companies are increasing annually and the services they offer cover almost every phase of structural, mechanical, electrical and process operations.

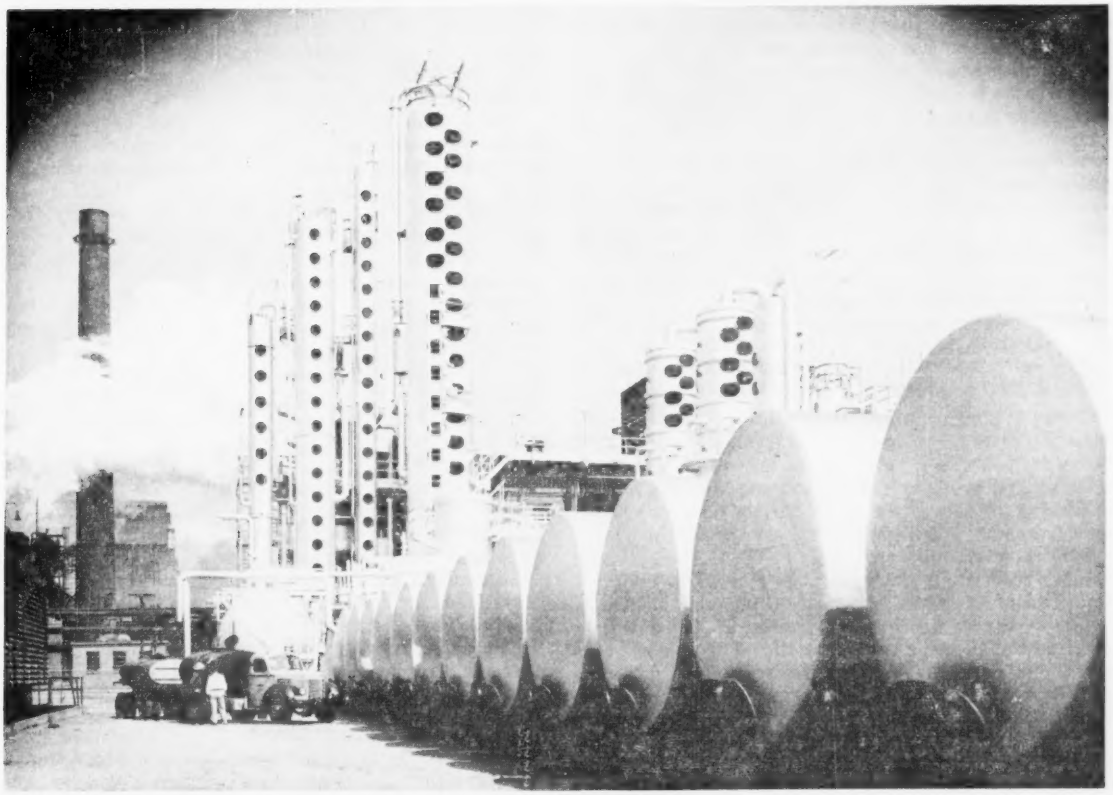
Not only does the problem of minimizing costs encourage development of specialized services, but the growing complexity of the tax problem also boosts the use of contract maintenance.

Every reasonable cost that can be listed as an expense means a tax saving. Every labor service that can be purchased means less fixed overhead and fringe benefit costs. Leasing of equipment from a contractor reduces capital expenditure for specialized items.

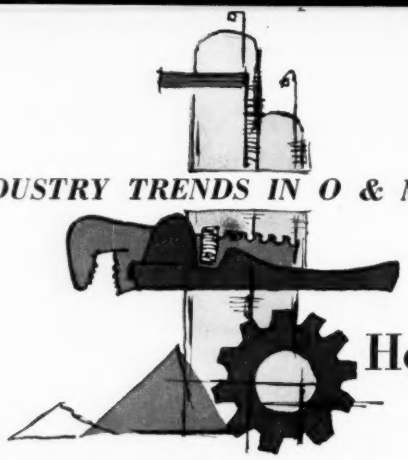
From the standpoint of the plant operator, the contractor offering maintenance services is a welcome addition to his forces and facilities.

On the other hand, the contractor must approach this growing area of activity with some caution. It's not enough to have skilled craftsmen, tools, equipment and techniques. Contractors must also have a good understanding of the operator's problems, general processes carried out in the plant, materials processed, hazards involved and consequences of delay.

Truly, a partnership exists and both operating and contracting companies in the process industries benefit.



CHEMICAL cleaning of process equipment has become an important maintenance function that's regularly done on a contract basis. Contractors offer labor and equipment and don't need the lessee's facilities. (Dowell)



INDUSTRY TRENDS IN O & M

How Leasing Conserves Capital

Compare leasing to conventional methods of financing plant equipment to find resulting cash accumulations.

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Today's chemical engineer encounters a most complex set of rules for determining the real economics of a new process or process change. The constant inflationary pressures of the past several decades as well as complex tax demands have increased the competition for capital within most companies.

It is essential that the enginer evaluating the economics of a particular process or change in process consider alternative methods for financing the proposed project. Very often a critical analysis of this aspect of the problem may mean success or failure in getting project authorization.

It is my opinion that all too often, an engineer may accept a more or less arbitrary cost of capital for his evaluation without giving much thought as to why such a value is used. Very often the cost of capital can be a major portion of the total operation cost.

Most of us consider the cost of capital to include the usual items of depreciation, insurance, interest and other fixed charges. To the needed capital drawn from available funds, some assign an interest rate representative of what could be realized from this capital if it were invested outside. From such capital cost and other operating cost figures, we can calculate comparative return expected from the investment. From this expected return, we can estimate payout time.

Origin of Capital Is Important

There are many sources of capital available for new enterprises. A common source in the chemical industry is to draw directly from profits or working capital. This source provides capital without diluting equity or risking interference from an outside lending agency. However, it is not always the cheapest capital to use.

Where satisfactory credit can be established, a short or long term bank loan can finance 50 to 75% of the total cost of a new project. Since this money is usually available at reasonable interest rates, the use of equity capital to finance the remaining 25 to 50% allows substantial leverage on earnings. However, debt financing of this type is not always available. We must also remember that the entire debt may be carried as a liability on the company statement and can affect the current ratio adversely.

Other methods of debt financing are available such as sales subject to chattel mortgages or other conditional sales. These methods may have the advantage of not directly diluting the corporate borrowing power. However, they can be most costly for securing capital.

Very often a sizable project requires the securing of more equity capital. Of course, equity capital is not the cheapest capital available but has the advantage that it involves no obligation of repayment.

Leasing as a Method to Create New Capital

The concept of a long term lease for financing new equipment is often overlooked. W. R. Heins in a recent study for The Foundation for Management Research points out that industry in general has no hesitancy in leasing real estate preferentially to ownership, but tends to shy away from using this same concept in process equipment financing.

During the past twenty years, real property has tended to appreciate rather than depreciate while equipment has tended towards rapid obsolescence because of technological improvements. Therefore, it appears logical to invest capital in real property that will appreciate rather than equipment that will depreciate. This is certainly not the whole story, but the concept is thought-provoking.

Chemical process companies during the past few years have shown an increased interest in the concept of leasing. H. Jefferies, comptroller of Sinclair Oil Co., stated in a recent article before the American Petroleum Institute "that current interest in long term lease of physical assets has stemmed largely from a combination of circumstances.

"These are: (1) the urgent need by business for additional capital, induced particularly by the necessity for replacement and expansion of facilities during a period of rapidly mounting costs; and (2) the superabundance of money in the hands of certain eager investors, particularly insurance and education or charitable institutions, certain of which enjoy or have enjoyed until recently, a tax exempt status."

The chemical engineer or the economist must not overlook this large source of capital and should certainly include it in any economic study.

Why Lease?

In considering leasing as compared to ownership, let us examine some of the merits found in lease arrangements.

• Freeing capital for other uses and reducing size of the corporate debt. Not increasing the demand for dividends by increasing equity capital.

• Freeing working capital for other uses such as inventories or receivables at higher turnover rates.

• Freeing working capital for profitable financing of customer purchases.

• Transferring obsolescence risk from lessee to lessor.

• Can provide allowance of rentals as expense item for tax purposes.

• Providing new equipment for short term period needs when type and capacity have not been clearly defined.

Leasing is really the conversion of a fixed asset to a current asset and thus creates more liquidity in corporate financing.

It is also important that the financial analyst consider the effect of new investment on the total corporate financing. Frequently the demand for new investment comes at a time when such financing through the usual channels may prove inconvenient. For instance, competition may require an immediate change in process or equipment.

Failure to move quickly may obsolete the product or process or may even result in failure in face of competition. Also a technological lead in a competitive business may permit writing of long term contracts on a suitable basis to obtain an edge over competition.

Use Leasing for Expansion

Perhaps one of the most favorable situations for a lease is for corporate expansion. The company may have a special market situation but lacks ready capital to finance this expansion.

We find a good example of this case in the steel industry. At the end of the war, the steel industry realized that the quickest and lowest cost method for immediate expansion was the substitution of oxygen for air in processing. Thus, we witnessed the enrichment of blast furnace air to increase capacity of the furnace; use of the oxygen lance to shorten heat time in the open hearth and the use of the oxygen converter to increase production and product quality.

These changes required some modification or replacement of the process equipment. More important, the economics were favored by installing oxygen producing equipment. This equipment is complex and expensive. Hence, the industry almost without exception leased rather than purchased this equipment, thus freeing capital for more profitable uses.

What Equipment Is Available for Leasing

Any capital equipment that has a reasonable life should be available for lease. Some manufacturers are especially equipped in their corporate structure and have access to capital so they can lease equipment directly.

Such arrangements have an advantage to the user (lessee) and to the manufacturer (lessor). When a manufacturer of the equipment leases such equipment, title remains with the manufacturer during the leasehold period. Consequently the lessor maintains a real interest in the performance and maintenance of the equipment.

There are also numerous leasing companies who are really specialized finance companies. The firms buy certain equipment and lease it back to the user. In such arrangements, the lessor can not maintain the same interest in the equipment, since he is strictly a financial company and not an equipment builder.

What Are the Basic Economics of Leasing

Leasing is certainly not a panacea and must be considered and analyzed for each case. There are too many generalities made in attempting to justify this method of financing.

By comparing capital costs for equipment that is leased with the cost of ownership, we can see the justification for leasing.

	Ownership	Lease
Depreciation	6.7%	0%
Interest	3.0	0
Insurance	2.0	0
General and administrative	1.0	0
Rental	0	17
Total	12.7%	17%

From the preceding table, we conclude that a savings of 4.3% per year of the invested capital can be realized by ownership. After deducting income tax at 52%, the resulting savings are only 2.07%/yr. If we add depreciation of 6.7% to the net savings of 2.07%, we get a payout of 8.77%/yr. or 11.4 yr. In most industries, this payout is unfavorable. Capital can be used to better advantage.

However, this method is only the first step. An analysis must include all possible methods of acquiring capital and comparisons made. Actually, the real basis for comparison is the accumulation of cash through depreciation and net profits. The financing structure yielding the greatest cash accumulation per unit of working capital will be the logical one to choose.

Let us use this concept in analyzing and comparing various methods of financing with leasing. For this study, let us take a hypothetical case where a certain chemical plant cost $1,000,000. Let us assume the plant will yield an income of $600,000 per year (sale income less operating costs) before subtracting depreciation and taxes.

For simplicity in arithmetic, we will assume plant depreciation over a ten year period on a straight line basis at 10%/yr. Income taxes are projected at 50%/yr. Furthermore, let us assume this particular industry can reasonably project a 20% return before taxes on its working capital over this ten year period. In comparing the methods of finance, we are assuming a hypothetical lease cost of 15%/yr. or $150,000/yr.

Different Methods of Financing Plant

Purchase, Table I

(Plant purchase price equals $1,000,000.)

Year	Profits Before Depreciation And Income Tax	Depreciation At 10%/Yr.	Income Tax At 50%	Cash Retained	Cash Accumulated*
1	$600,000	$100,000	$250,000	$250,000	$ 350,000
2	600,000	100,000	250,000	250,000	700,000
10	600,000	100,000	250,000	250,000	3,500,000

*Cash accumulated equals depreciation plus net profits.

Lease, Table II

(No capital outlay for plant.)

Year	Profits Before Rental and Income Tax	Rental Payment	Income Tax At 50%	Cash Retained	Cash Accumulated*
1	$600,000	$150,000	$225,000	$225,000	$1,225,000
2	600,000	150,000	225,000	225,000	1,450,000
10	600,000	150,000	225,000	225,000	3,250,000

*Cash accumulated equals net profits plus $1,000,000 purchase price saved.

Conditional Sale, Table III

(Terms: $250,000 down, $750,000 balance payable in 10 years with interest at 5% on $750,000.)

Year	Profits Before Taxes, Interest, Depreciation and Amortization	Depreciation Of Equity	Amortization	Interest	Income Tax At 50%	Cash Retained	Cash Accumulated*
1	$600,000	$25,000	$75,000	$37,500	$231,250	$231,250	$1,006,250
2	600,000	25,000	75,000	37,500	231,250	231,250	1,262,500
10	600,000	25,000	75,000	37,500	231,250	231,250	3,312,500

*Cash accumulated equals depreciation plus net profit plus cash saved by borrowing.

Bank Loan, Table IV

(Terms: $500,000 down, $500,000 balance in 10 annual payments with interest at 5% on unpaid balance.)

Year	Profits Before Taxes, Interest, Depreciation and Amortization	Depreciation At 10%/Yr.	Loan Amortization	Interest	Income Tax At 50%	Cash Retained	Cash Accumulated*
1	$600,000	$100,000	$50,000	$25,000	$237,500	$187,500	$ 787,500
2	600,000	100,000	50,000	22,500	238,725	188,725	1,076,225
10	600,000	100,000	50,000	2,500	248,750	198,750	3,431,225

*Cash accumulated equals depreciation plus net profits plus cash saved by borrowing.

Evaluation of Greater Cash Availability:

Leasing vs. Purchasing, Table V

Year	Added Cash Accumulated By Leasing	Earnings Available From Added Cash At 20%/Yr.	Income Tax On Added Earnings At 50%	Cash Returned Each Year From Added Earnings	Accumulated Cash From Added Earnings
1	$875,000	$175,000	$87,500	$87,500	$ 87,500
2	837,500	167,500	83,750	83,750	171,250
10	365,771	73,154	36,577	36,577	652,348

Leasing vs. Conditional Sale, Table VI

1	$218,750	$43,750	$21,875	$21,875	$ 21,875
2	209,375	41,875	20,938	20,938	42,813
10	91,444	18,288	9,144	9,144	163,088

Leasing vs. Bank Loan, Table VII

1	$437,500	$87,500	$43,750	$43,750	$ 43,750
2	417,525	83,505	41,753	41,753	85,503
10	108,724	21,745	10,878	10,878	300,827

Lease Vs. Purchase

A breakdown of cash accumulated over a ten year period is shown in Table I. Here we assume the plant is purchased using the company's working capital. Total cash, net profits plus depreciation, accumulated at the end of ten years amounts to $3,500,000.

In Table II, we trace the cash accumulation assuming the plant is leased at a rental charge of $150,000/yr. For direct comparison with the purchase of the same plant, note that the $1,000,000 that would have been used to purchase the plant is available the first year for other purposes. Thus, the first year's cash accumulation amounts to $1,225,000 which represents the plant purchase price plus the net profits after taxes.

Let us compare these two plans on a year by year basis taking into account the capital that is freed by leasing the plant instead of using working capital.

In Table V, we trace the cumulative earnings that result from this freed capital. We have taken the difference between the accumulated cash each year represented by the purchased plant and the leased plant. We assume this cash will earn an average of 20%/yr. before taxes in other areas of the company. The accumulated cash returned from these earnings each year is added as cash available the next year.

Note that by leasing the plant, we realize an increase of $652,280 in cash accumulated in ten years.

Lease Vs. Conditional Sale

The conditional sale is often considered an attractive method for financing new equipment.

In the hypothetical case, let us assume a down payment of 25% with the balance payable over a ten year period carrying a 5% interest rate on the purchase price or $37,500/yr. Cash accumulation is developed in Table III showing a total of $3,312,500 at the end of ten years.

In Table VI, the lease is compared with the conditional sale on the same basis as previously shown in Table V. Again note that the lease plan is more favorable than a conditional sale.

Lease Vs. Bank Loan

A long or short term bank loan is often considered a desirable way to finance new equipment. It is usually considered as low cost financing without danger of diluting equity but with the disadvantage of reducing borrowing power. There is also the possibility of making the company statement more unfavorable.

Let us assume that 50% of the plant can be financed through a short term loan renewable yearly for a ten year period at 5%. The principal is to be retired yearly over the ten year period on a straight line basis while interest is calculated as 5% on the unpaid balance.

Cash accumulation is developed in Table IV showing a total accumulation of $3,431,225 at the end of ten years. In Table VII, we compare the bank loan purchase with a lease plan. Here we note that an additional $300,827 has been generated by leasing rather than purchasing via a bank loan.

In the last two cases, the conditional sale and the bank loan purchase, Tables II, III and IV show leasing at an apparent disadvantage. This is rectified in that earnings from the use of freed capital as shown in Tables V, VI and VII substantially exceed the difference in the superficial analysis.

However, note that the conditions set for this study are hypothetical and do not necessarily represent the terms and conditions that can actually be realized. They are selected to show a suggested method of evaluation after determining the exact terms available for each method of financing.

Other Factors to Consider

There are other factors that must be considered as fringe benefits. Some of these factors are:

1. Possible obsolescence before expiration of the leasehold period. For such a contingency, the lease can contain bail-out provisions. If the lessor is the manufacturer, the equipment can be modified or replaced.
2. Maintenance of the equipment can be provided by the lessor, particularly if the lessor is the manufacturer. Local conditions will be a determining factor in establishing the advantages or disadvantages for such an arrangement.
3. Tax advantages can sometimes be realized. However, each case should be checked individually with a tax analyst before such advantages are assumed.
4. Insurance and indemnification provisions should be considered. Where the manufacturer is the lessor, these are probably included in the lease cost.
5. Other methods of depreciation may be used. Certain advantages can possibly accrue by utilizing the sum of the digits or the declining balance methods of depreciation, which may also be applied to leases. Advantages that might accrue to the lessor may be passed on to the lessee.
6. It may be advantageous to have the lessor operate this equipment with either a separate operating contract, or a contract whereby the product is sold on a unit basis. In the latter case, a contract can be written closely paralleling a utility contract where a demand charge is established using sliding scale pricing based on the actual consumption. These types of contracts have the advantage of relieving the user of complete responsibility as well as capital requirements.

A rigid analysis must be made along the line indicated in this article for each case. A determination must also be made as to the most favorable method for financing. The conclusions will vary from industry to industry and among projects in the same industry.

I wish to acknowledge the assistance of Messrs. Cummings, Steele, Stewart and Francis of Air Products, Inc., in the preparation of this article.

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Select and Design for Operation

Operations Define Dryer Design

Materials handling characteristics of dryers influence their selection for optimum use and easy maintenance.

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Among the many design factors which the process engineer evaluates in the selection of drying equipment, only one directly pertains to its function as a vehicle for heat and mass transfer. The remaining factors pertain to the solids handling characteristics.

The profitable manufacture of so many different forms of commercial dryers demonstrates the major importance of solids handling. Each dryer is valued not because of its superior drying capabilities, but because each possesses unique material handling properties needed for processing certain kinds of solids.

One dryer may be attractive because it permits efficient vapor recovery, discourages dusting of solid particles, reduces particle attrition, or possibly because it can be cleaned easily. On the other hand, the shape in which a dried product is delivered may be its significant quality—such as flakes from drum dryers or the spherical particles obtained from spray dryers.

The essential problem of the process engineer is to compare the special properties and requirements of the substance to be dried with the characteristic operating features of alternative dryers. On the basis of these comparisons, the process engineer selects the most compatible match for his process.

Drying theory is of only limited use in this phase of design. The application of theoretical methods is in the sizing of drying equipment rather than its selection. And even here we can use theory with complete confidence only when processing solids which do not misbehave physically or change form. Theory is used in preliminary sizing and in development of specifications for comparative evaluations.

In most instances, we continue to rely on semi-works tests for the firm specification of drying equipment. In these tests, the assumed effects of solids properties on dryer performance can be confirmed accurately and the presence of any unforeseen operating difficulty is most likely to be detected.

This is not meant to deprecate the value of theoretical studies in developing a better understanding of classical drying processes. The important point is that solids processing criteria have a much greater influence on the design of commercial installations.

In this article, dryer and system design will be considered mainly from the operating standpoint. Factors will be discussed relating to materials which may influence the selectional use of commercial drying equipment, but not necessarily affect drying performance.

Drying equipment manufacturers devote considerable attention to features for easy maintenance as a corollary method to enhance acceptance of their products. When serious or unusual maintenance problems develop in a drying installation, it usually indicates a poor product application of the particular dryer.

Drying and Mechanical Dewatering

Frequently, the first question faced by the process engineer in undertaking the design of a dryer installation is where in the process to begin drying. This factor has become increasingly important as a result of the widespread application of modern flash and spray drying processes.

At first glance, it often appears that the substitution of a one-step drying process in place of a traditional filtration, centrifugation or evaporation-drying operation may greatly simplify the operating task.

The value of these processes cannot be over-estimated when processing heat sensitive materials. The materials may be those which can not be efficiently dewatered by mechanical methods, possibly those which remain fluid at very low moisture contents, or those in which it is desired to develop the unique particle shapes attained only by spray drying. However, for other applications, even when investment and operating economies appear attractive, complete water removal in one step is not always a desirable alternative.

There are two common operating problems which should receive serious study before selection of any of the so-called flash-drying processes.

The first is dust recovery. It requires attention because large quantities of warm air are necessary to transport heat to the solids and then to carry off the vapors. In a flash dryer, each pound of water in the evaporative load requires between 4 and 40 lb. of air passing through the system for this purpose. After it cools this air should be cleaned in dust recovery apparatus to minimize product losses and to avoid cre-

and Maintenance

ating a dust nuisance to the surrounding plant area.

The bulk of the larger particles of entrained dust can usually be recovered in conventional cyclone collectors, but these are never 100% efficient. For maximum cleaning and dry recovery, cloth bag filters become necessary.

Wet scrubbers are less expensive and simpler to operate and maintain. However, wet scrubbers require either that the product be easily recovered from a liquid and reprocessed without quality damage or that it can be economically discarded.

Spray and similar dryers in which solids particles are suspended and conveyed in an air stream are especially susceptible to dust losses. In addition, they are often characterized by very fine, low density products which in association with high moisture loads and air volumes also increase the problem of dust recovery.

The argument here is not that it may become impossible to recover all dust. Given proper equipment this can always be accomplished. However, high efficiency dust collectors are expensive to install.

Also, if the particles are extremely fine or if their sizes cannot be effectively controlled during drying, continued operator attention for cleaning, unplugging, or the replacement of bags may quickly outweigh all other advantages accruing from the process.

The second possible operating hazard to which flash dryers are susceptible is that of an adhesive product sticking to the equipment parts.

The stickiness of most true solids usually decreases as dryness is approached and increases with increasing moisture content. There are methods by which a solids feed can be treated to reduce sticking and these are discussed later. In a spray dryer, however, or any dryer in which a solution or slurry is handled, contact of the droplets with the chamber walls should be avoided until drying is complete.

A large diameter spray chamber is desirable for the purpose, but the need is frequently overlooked during design in an understandable desire to shorten or steepen the conical section at the bottom to reduce over-all height and prevent accumulation of solids on the sloping walls. On the other hand, a small diameter, very high chamber is frequently designed to provide longer retention of the particles in the drying atmosphere without increasing dryer volume.

Feed Control and Recycle Mixing

Another frequently encountered and troublesome problem in dryer operation is that of maintenance of consistent feed properties. A simple variation in moisture content alone is only one form of this difficulty. It may usually be dealt with by providing sufficient excess capacity in equipment design.

The problem becomes serious when a change in moisture content, particle size or other uncontrolled variable produces a significant change in the physical behavior of the feed. A common example is a normally dry, crumbly filter cake which is transformed by a slight moisture content change into a semi-fluid which sticks, snowballs, or casehardens in the dryer.

Extruders, flakers, pelletizers and other preforming devices are particularly sensitive to changes in feed behavior because they customarily function ideally within narrow limits of solids-flow characteristics.

A complete production breakdown from this source may be less of a hazard in a batch dryer than in continuous equipment, because a troublesome condition can be recognized prior to loading.

Upon a change of the crumbly cake to a semi-fluid, the latter may quickly boil and spill if exposed to the same initial drying temperature. It may caseharden at the surface and not dry sufficiently inside, or it may become simply messy and wasteful to load and upset schedules by prolonging batch cycles.

In spray dryers and occasionally in drum dryers constant feed properties are maintained by diluting the feed stream with water as necessary.

The comparable solution to the problem of feed uniformity when drying pastes, plastics or other semi-solids is usually found in the use of a dry solids recycle system. In this, dried solids from the discharge end of the dryer are continuously returned and mixed with raw wet feed to yield optimum feed properties.

In its basic elements, a continuous recycle system consists of a conveyor to return a fraction of the dryer discharge to the feed end, a hopper in which to store it, a controlled feeder and a mixer to blend it with wet solids. Despite its apparent simplicity, however, careful planning during design of the process is necessary to obtain maximum operability.

Return conveyor should be enclosed and thoroughly insulated to retain a maximum fraction of the sensible heat in the solids.

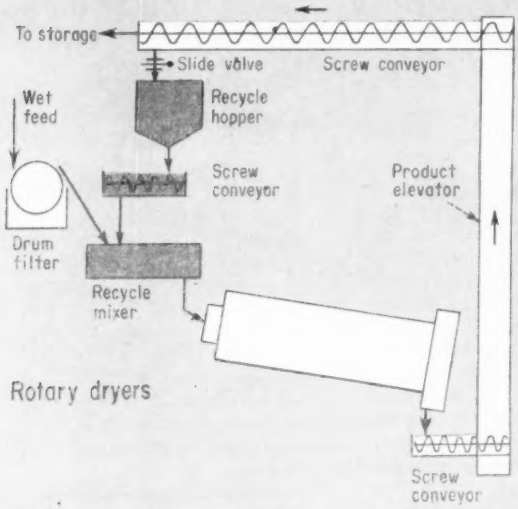
Recycle hopper must have a capacity equal to at least one and preferably two or three times the dryer fillage. Without this capacity, the system may never be properly started. In many cases, if recycle is required the dryer can be fouled by the initial batch without mixing. Skimping on hopper capacity is poor economy.

Another useful function of hoppered reserve presents itself when the dryer discharge is not uniform or stops completely from time to time. Its dampening effect then becomes available to prevent an upset in the operation of the recycle mixer.

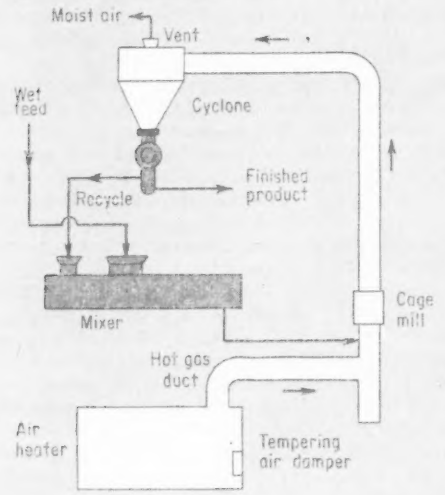
Recycle mixers are customarily of the high speed, double shaft paddle variety. Regardless of form, they must be large enough and sufficiently flexible to develop a very intimate blend. One of the most frequent causes of dissatisfaction with recycle installations is poor blending.

A dryer feed composed of wet lumps poorly mixed

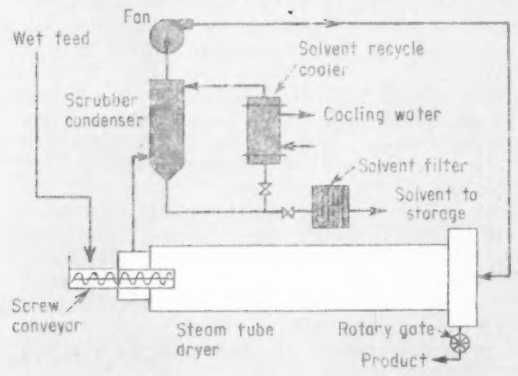
Recycle Mixing Yields Consistent Feed Quality



Pneumatic conyeyor dryers



Inert Gas Circulating System Recovers Solvent



with fine, dry particles will cause sticking of the lumps and also result in excessive dusting. To make matters worse in these circumstances, a change in the composition of the feed in either direction will only aggravate one of the problems.

Considerable study and expense is justified to be certain that an adequate mixer is provided. To this end, it is not unusual to follow a paddle type recycle mixer with a high speed hammer mill or disk mill to further guarantee uniform blending.

Thixotropic materials require special precautions during process design if the need for recycling is contemplated. Due to the effects of agitation, the first result of blending with dry solids may be an increase in fluidity rather than a decrease and the ultimate quantity of recycle solids required may far exceed that normally considered adequate.

The principal money investment will probably be in the additional dryer volume required to accommodate the added bulk of the circulating solids. The cost of a conveyor, hopper, and mixer is usually not large. The economics of a recycle system is partially a function of the type of dryer being used.

Rotary vacuum dryers, for example, with their relatively high unit volume values, are much less attractive costwise for recycle applications than a direct hot air rotary dryer.

Although the recycle method is applicable to many forms of dryers and products, it is obviously not suitable for materials which cannot tolerate long exposure in the drying atmosphere. Once circulation has been started, there is no effective control on particle residence in the system.

The outstanding value of the recycle process is in the fact that it can greatly extend the useful application of many dryers. For example, rotary dryers which historically have been used exclusively for completely free flowing solids can be economically adapted for pastes, plastics, slurries and liquid solutions. The same holds true for direct, through-circulation dryers which frequently operate in association with preforming equipment and require feed stock with consistent and controlled properties.

Probably the chief disadvantage of the recycle process is contained in the fact that as dryness is approached, evaporation becomes less efficient. The last traces of moisture are usually the most difficult to remove from solids. By dispersing the moisture contained in the undiluted feed, its evaporation may become more difficult. On the other hand, recycle may increase the capacity of a given dryer several-fold.

Recycle mixing should be considered in any case where the application of an otherwise desirable form of dryer appears questionable because of feed properties alone or in a case where the capacity of an existing installation is limited by unfavorable feed characteristics.

Drying and Vapor Recovery

In present day industry, the drying of solids frequently involves the removal of liquids other than water. Recovery or at least safe and controlled dis-

posal of the vapors which may be flammable or toxic organic solvents is necessary.

The traditional recovery equipment has been the batch vacuum-type dryer, operated at reduced pressures and equipped with surface condensers, followed by steam jets or vacuum pumps. When handling low boiling vapors, the operating pressure is kept high enough relative to the coolant temperatures to assure efficient condensation.

Early and successful continuous equipment was the simple screw conveyor dryer used extensively for solvent recovery following oil and fat extraction processes. The nature of pretreatment in these processes insures that the solids remaining at drying are insoluble in the liquid.

Sticking inside long enclosed lengths of conveyor should not be permitted to occur to foul the heating surface under this condition. Several more refined types of scraped-tube screw-conveyor dryers have since been developed to reduce adhesion of sticky solids.

Indirect rotary steam tube dryers have been improved to a degree that they also are applicable for continuous recovery operations. Efficient rotary seals and solids feeders are available which permit operation under pressure or slight vacuum.

An inert gas circulating system is the means customarily employed for vapor removal from inside the shell. Large diameters permit moderate gas velocities which minimize dust entrainment.

Steam tube dryers also require close attention to feed characteristics to prevent coating of heating surfaces. They may be operated under slight pressure if air contamination from outside cannot be permitted, or under slight vacuum if leakage of the vapors to the outside is the controlling restriction. In either case, pressure differentials across the feed and discharge valves and other seals should be no greater than absolutely necessary to maintain gas tight conditions.

Solvent recovery in direct dryers presents a number of operating problems. Not only do the high air flow rates cause dusting, but dilution of vapors and consequent vapor pressure reduction makes recovery much more difficult. Regardless of whether the drying medium is air discharged to atmosphere or a recirculating inert gas, dust collection is necessary.

In a recirculating gas system, efficient air filtration is usually necessary to prevent fouling of the circulating gas heater. Good vapor recovery values are possible using the recirculating system. The additional hazard of fire is present when using direct air drying for the recovery of flammable vapors.

Although it is not necessary to pass recycled gas through the heater of an indirect dryer, it is nevertheless desirable to clean dust from the stream to minimize the quantity of circulating fines. A direct contact scrubber using cooled solvent spray serves the dual purpose of knocking out dust and condensing solvent vapor.

The liquid overflow from the scrubber is filtered and returned to process, while just sufficient solvent is circulated through a shell and tube heat exchanger to maintain a supply for the scrubber. A mechanical fan provides gas circulation.

Another technique utilizes a liquid eductor to condense vapor, collect dust and recycle gas through the system. If there is absolute assurance that no dust will be carried in the gas stream, indirect cooling and condensing of vapor may be done without scrubbing.

Frequently, the pressure of the vapor alone conveys it to the condenser and no carrying gas is necessary. In this case the atmosphere of the dryer consists solely of vapor. This technique should be restricted to batch operations where the vessels can be thoroughly purged prior to opening.

In continuous processes, serious vapor losses may be experienced at the solids feed and discharge valves. A safety hazard is also created where flammable or toxic vapors are involved.

Design Considerations for Rotary Dryers

In spite of the increasing attention which is devoted to newer developments, continuous rotary dryers in their several modified forms continue to represent some of the most popular and widely used industrial drying equipment. Their popularity is attributable to simplicity in design and operation, great versatility, and low initial investment and operating costs.

The two common styles of continuous rotary dryers are the direct air rotary or convection form, and the totally indirect rotary. The second type is best exemplified by the indirect steam tube dryer.

For operating, cleaning, and maintenance convenience, rotary dryers with lifting flights should always be designed with shell diameters of at least 48 in. Exceptions are very small dryers less than 12 ft. in length and where all internal parts can be reached easily from outside.

In others, the slight investment increment required to provide a shell of sufficient size to permit full access is usually quickly returned in labor savings for cleaning and maintenance.

The same access provisions should be allowed in the design of the lifting flights and interior baffles or diaphragms. The additional cost of a complex interior structure usually claimed to be justified as a means of improving heat transfer, is much better invested in slightly greater over-all dryer volume.

Another important advantage of a large shell diameter frequently appears when drying solids which have a tendency to adhere to the dryer parts. A large shell not only provides greater volumes in which a build-up may extend before it blocks product flow, but it also presents fewer points from which large masses can gain support.

Auxiliary devices often eliminate sticking in rotary dryers. Strategically located knockers on the outside may aid. Knockers are very effective and represent no special operating problem except possibly in the higher noise levels created in the area.

Hanging chains attached to the flights will assist in breaking large lumps. However, chains represent a source of high maintenance and cause rapid wear of interior parts. They are most successfully used only in brick-lined kilns or steel shells with smooth unobstructed surfaces. A simple uncluttered interior

Guide to Dryer Evaluation and Selection

Batch Dryers

Advantages	Limitations
Direct heat tray dryer (Typical product: color pigments)	
Small batches, easily cleaned, flexible operating cycle, can use for different products.	High labor costs, relatively long drying cycle, not suitable for very dusty products.
Indirect vacuum tray dryer and vacuum freeze dryer (Typical products: pharmaceuticals, freeze-dried foods)	
Small batches, easily cleaned, flexible cycle, permits vapor recovery, low temperature drying, air exclusion.	High labor costs.
Indirect agitated pan dryer (Typical products: ore concentrates, wood flour)	
Small batches, easily cleaned, vacuum or atmospheric operation, flexible cycle, solvent recovery.	Particle attrition by agitator, not suitable if product sticks to heating surface.
Indirect vacuum rotary and rotating dryer (Typical products: pharmaceuticals, heat sensitive foods)	
Large batches, flexible cycle, double-cone blender shape permits rapid discharge and easy cleaning, solvent recovery, low temperature drying, air exclusion.	Some particle attrition in both rotary (with agitator) and rotating forms, requires dust scrubbing, not suitable for products which stick to heating surface.

Continuous Dryers

Advantages	Limitations
Indirect drum dryer and vacuum drum dryer (Typical product: milk powders)	
Will handle solutions, slurries and pastes, can produce dust-free flakes as product.	Not suitable for very low moisture drying—less than 2 to 5%, requires finishing dryer in these cases, vacuum form difficult to seal.
Pneumatic conveying dryer (Typical product: plastics granules)	
Rapid drying, conserves space, permits drying in transit over long distances in plant.	Not suitable for sticky products or those containing other than surface moisture, particle attrition, requires air cleaning dust collectors.
Fluidized solids dryer (Typical products: fine coal, salt)	
Excellent gas contacting and heat transfer, permits particle classification, high capacities, no moving parts.	Requires fairly uniform feed, no very coarse lumps, not suitable for cohesive particles.
Spray dryer (Typical products: soluble coffee, milk powders)	
Short contact, rapid drying of heat sensitive solutions and pumpable slurries, produces unique spherical shapes.	Dust collection required, needs fairly large space, not suitable for sticky products or slow drying materials.
Direct continuous screen or belt conveyor dryer with parallel or through circulation flow (Typical product: pigment filter cakes)	
Permits semi-continuous batch separation, no relative particle movement or attrition, long residence time, precise control.	Not suitable for extremely fine, dusty particles or those forming impervious beds, plastics and stiff pastes.
Direct continuous tray dryer (turbo-dryer) (Typical product: crystalline salts)	
Continuous gentle agitation permits uniform drying, precise control of retention, little particle attrition.	Not suitable for sticky or very dusty products, difficult to clean.
Direct through circulation rotary dryer (Typical product: fertilizer pellets)	
High volumetric thermal efficiency, does not require showering of particles, uniform heating.	Not suitable for fine, dusty particles, requires coarse granular particles forming pervious beds.
Direct air rotary dryer (Typical products: sand, sodium chloride crystals, ilmenite ore)	
Most flexible continuous dryer, suitable for wide range of products, showering permits efficient heat transfer, high thermal efficiency.	Not suitable for extremely fine, dusty particles or those which cannot be showered during drying, retention control is not precise.
Indirect air rotary dryer (Typical products: brewers grain, carbon black, titanium pigments)	
Reduced gas flow rate limits dusting, showering of particles not necessary, easily sealed for vapor recovery or air exclusion. Steam tube form is least expensive type of heating surface.	Surface subject to fouling by adhesive products, product temperature likely to approach surface temperature at end of drying, retention control is not precise.
Screw conveyor dryer (Typical product: residual solids from solvent extraction)	
Conserves space, good control of retention, low gas flow reduces dusting, rotary seals not needed for air exclusion.	Surface subject to fouling, difficult to clean, particle attrition.
Vibrating conveyor dryer, direct and indirect (Typical product: explosive pellets)	
Conserves space, good retention control, low gas flow, reduces particle attrition	Not suitable for sticky, cohesive solids, vibration dampeners and flexible connections required.
Direct tower dryer (Typical product: grain)	
Few moving parts, good gas contacting and heat transfer slowly flowing bed reduces attrition.	Not suitable for sticky, cohesive solids, uniform downward flow difficult to maintain.

Dryers With Special Heat Sources

Advantages	Limitations
Direct, superheated vapor dryer (Typical products: wood products)	
Air and foreign gases excluded, may increase transfer coefficient slightly over air, suitable for vapor and solvent recovery.	Recirculation, reheating and probably dust scrubbing required; needs sealing and insulation; over-all thermal efficiency poor.
Infrared heat dryer (Typical products: enameled metals, plastic sheeting)	
Suitable for films, sheets and thin layers. No combustion gases to handle, high energy concentration possible.	Does not penetrate surface layers, not suitable for thick materials, danger of overheating, over-all efficiency poor.
Dielectric heat dryer (Typical product: foam rubber)	
Suitable for uniform drying and heating of large objects.	Not suitable for particulate solids, efficiency low, very expensive.

flight design is also a good guarantee that serious sticking problems will rarely be encountered.

Excessive dust loss from rotary dryers is an operating hazard which can also be significantly reduced by careful design. Here again, the use of a large diameter shell will aid by reducing air velocities. For extremely dusty materials totally indirect dryers are of course, most suitable. These require a minimum gas flow to remove the vapor as the gas is usually discharged very close to saturation.

The second most attractive type for dusty materials is the countercurrent-flow rotary dryer. Effective dust scrubbing can be achieved by intense showering of damp solids near the feed end where the gas velocity is the lowest. The use of perforated flights to screen out fines and shower only coarse particles near the dry end is a technique which reduces entrainment.

Complete elimination of lifting flights at the hot end where the gas velocity is the highest represents a possible aid, but this may also reduce efficiency and prevent drying of the larger particles.

The discharging air is usually removed through the top of the feed breeching. The right angle turn here will cause some dust to be thrown out. Once the air enters the duct leading to the dust collector and fan, care should be exercised that it will not settle. In design, an air velocity in the range of 100 fps. should be provided inside the ducts.

Dry cyclone collectors are the customary form used with direct dryers because of the advantage of dry product recovery. The cyclone should be installed upstream from the exhaust fan to prevent unnecessary wear on the fan elements.

Very often, if all possible precautions are taken to check dust entrainment inside the dryer, the ultrafine particles which are carried into the cyclone will be dry enough to add directly to the dry product stream.

Direct co-current dryers are mainly used for heat sensitive materials which cannot be exposed to high temperatures in the dry state. When processing these products, much higher thermal efficiencies may be obtained than in the countercurrent form. Direct co-current dryers are also suitable for many other processes in which precise control of final particle temperature is required.

When handling dusty products, serious losses are possible because the dry particles are exposed to entrainment in the air directly at its discharge and with no subsequent chance to settle out. Special co-current dryers with enlarged sections at the dry end are manufactured, to combat this particular problem.

Cloth dust filters can be used with direct air dryers when the discharge air temperatures are sufficiently low—say not more than 250 F.

The wet scrubber is the principal form used for dust collection with steam tube and other indirect dryers. The chief reason is that the exhaust air is usually so close to saturation that condensation occurs in any collector after slight cooling.

Particle breakage in rotary dryers is extensively discussed in the literature. Some disagreement exists on the virtues of the various dryer types. Probably the fundamental problem rests in the fact that breakage can occur in several ways. Whereas one particle may shatter on impact when falling from a distance, another may possess sufficient resiliency to withstand this abuse, yet quickly erode by attrition when rubbing or rolling on adjoining particles.

Although the first particle may be damaged when dried in large diameter dryers with lifting flights, breakage can be reduced in shells larger than seven feet by installation of a quartering diaphragm inside.

Flights may be attached to both the shell and diaphragm and this essentially forms four small dryers. Free fall particle distance is reduced by over half with, if anything, an increase in dryer efficiency. The second type probably should not be dried in a rotary dryer.

For use on dryers with direct oil- or gas-fired air heaters, modern short-flame burners are manufactured which do not require brick lined combustion chambers when air temperatures do not exceed approximately 1,500 F. Significant investment, weight and maintenance savings may frequently be obtained by their use. For higher temperatures, brick-lined chambers are still required. Access for maintenance is improved by mounting these chambers on wheels with tracks for backing away from the dryer shell.

Batch Tray Dryer Design

Batch tray (or truck) dryers are still the best choice for drying many different materials in the same equipment where ease of cleaning and flexible operation are paramount. Operating drawbacks are mainly in the high labor requirements and long drying cycles.

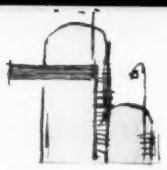
High labor requirements will never be eliminated entirely. They can be reduced by the use of centralized loading stations for trays or trucks and the provision of wide corridors with flat floors. Smooth floors for passage of trucks to and from the dryers will not only make moving easier but also reduce spillage losses.

Squeegeeing of cleaning water to the drains is usually preferable to continually hoisting the trucks over the ridges of sloped floors. Non-skid floor surfaces are an additional safety provision.

For maximum flexibility in direct drying operations, two speed circulating fan motors are useful. The drying cycle can be significantly reduced by the use of high air velocities during the early stages before surface drying is complete and dust develops. These rates may also permit the use of lower initial air temperatures to reduce surface crusting, without sacrifice in time, and may obviate turning the material in the trays at some point in the cycle. Design provisions should allow for an air velocity across the trays of 800 to 1,000 fpm. assuming the product can tolerate these high velocities.

Gas- or oil-fired air heaters should also be considered for the fresh air supply if a large quantity of make-up air is required to remove moisture.

For the attainment of maximum drying rates when drying dust-free, non-flammable products, direct fired circulating air heaters should be considered. These permit use of drying temperatures as high as the cabinet structure will tolerate, whereas steam heaters usually are not effective above 300 to 350 F.



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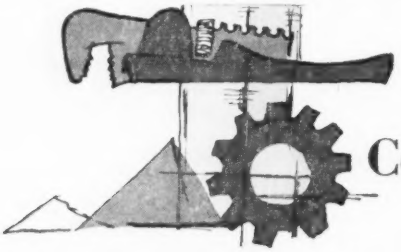


Continuous and Batch Filters

Make better filter selections by knowing the types you can choose from and their operating features.

GLEN G. REED, Director, Filtration Technical Div., Dorr-Oliver Inc., Stamford, Conn.

From penicillin to peanut butter, filtration plays an important production role in industry throughout the world. Few of us realize just how many of our common, everyday materials have been filtered at some time or other in their production. Such common and diverse products as table salt, baking soda, cement, wax, wine and fertilizer pass through or are retained on a filter medium in the process of clarification or concentration prior to final drying.

To accomplish the unit operation of filtration, manufacturers have designed and developed over the years a broad and extremely varied line of equipment. All of these filters can be classified into two basic types—those that operate continuously and those of the batch type. In the continuous group are the drum, disk and horizontal types, while batch filters are of the leaf, cartridge and plate and frame or filter press variety.

Most continuous filters operate under vacuum, but in many instances are pressure operated. On the other hand, the vast majority of batch filters are pressure units, and the application usually does not lend itself to vacuum filtration.

A frequent classification of filters is based on the primary product of the unit. "Cake filters"—those handling a slurry containing sufficient solids to deposit a relatively substantial cake in a reasonable length of time—include the drum, disk, horizontal, leaf and plate and frame types. "Clarifying" filters, which are used primarily to remove small amounts of solids from large quantities of liquids, are leaf or cartridge units although the precoat drum filter also falls into this classification.

Continuous Filters

Drum—The drum filter is perhaps the best known filtration unit and has served as the basis for the many variations in use today. Its basic design incorporates a compartmented drum or cylinder which revolves in a shallow tank containing slurry to be filtered. After passing through the medium or cover, filtrate is collected in the compartments and fed through pipes to a filter valve.

The basic drum filter may have a wire-wound cover or may be of the panel type. In the former unit the one-piece filter medium is wrapped completely around the drum and held in place by spiral wire windings at uniformly spaced intervals.

The wire-wound drum filter is particularly applicable to solids which form heavy and easily discharged filter cakes. The discharge scraper rides primarily on the wires rather than the medium. Cakes ‡ in. and more thick can be handled without difficulty, and the unit is ideally suited to cakes which require washing. A disadvantage, but not one of great magnitude, is the inconvenience in replacing the medium. This design is not suited for thin or sticky cakes.

The panel type drum filter has been specially developed to handle thin cakes. Here the drum cover is divided longitudinally into sections or panels. Longitudinal drum division strips and caulking, rather than spiral wire winding, are used to hold the panels in place.

As a result of this type of construction the medium is free during cake discharge to pull away from the drum surface below. This "bellying out" at point of discharge allows the scraper to lightly contact the medium and scrape off the thin or slimy cakes. As the medium becomes worn after repeated contact with the scraper, individual panels can be replaced without removing the entire medium. Often a disadvantage is a somewhat shorter cover life. Panel filters can discharge a cake as thin as ⅛ in., and cake washing is practiced where required.

A distinctly different drum filter is the precoat type drum unit designed specifically to handle slimy materials which would blind the usual cloth medium. A special material, customarily diatomaceous earth, is applied over the filter cloth to serve as medium. As this precoat surface becomes clogged with fine solids, the discharge scraper continuously removes both the formed cake and a very thin layer of precoat, thus continuously presenting a fresh surface to the slurry.

Precoat is initially applied to a thickness of two to three inches. Reduction of this coat is on the order of a few thousandths of an inch per drum revolution and is controlled by a mechanism which automatically moves the blade inwardly. When precoat thickness is reduced to about ‡ in., operation is halted and a new layer is applied. Operation of this unit is continuous for the life of the precoat, which may vary from eight hours to as much as two weeks depending upon the character of the slurry solids.

This filter produces a highly clarified effluent and is most applicable to low solids slurries. Cake washing has been successful on a limited number of applica-

tions, but generally speaking the precoat filter does not readily lend itself to this operation.

Initial installation costs are generally higher than for the conventional drum filter and, as might be expected, operation is more expensive due to precoat material costs. However, its operating costs are frequently less than for batch pressure filters utilizing precoat and admix.

Two different types of drum filters—the top feed and the internal drum—are available for solids which are rapidly dewatered. The former can best be utilized for both dewatering and drying granular or crystalline solids, which would tend to segregate in tanks of conventional units, and for high-solids feeds.

As the name implies, feed is introduced on the top of the drum and formed cake discharged near the bottom position. The unit is designed to provide cake drying by drawing large volumes of hot air through the cake. Dewatering and drying sodium chloride crystals was one of its early applications and for that reason it is often referred to as a "salt-type" filter.

The internal drum filter is used for dewatering coarse solids as handled by either top feed or horizontal filters, but it does not provide for cake drying. Heavy, rapidly settling solids are deposited on the inside of the drum and form a cake which would be difficult to form on the conventional drum filter. Solids are discharged as the drum reaches its topmost point and removed by chute or conveyor.

Basically, the internal drum filter is an excellent dewaterer and can be utilized in many instances where horizontal type filters are also acceptable. But this filter does not lend itself to washing. Also the unit may not be effective on extremely coarse and nonhomogeneous particle size cakes which roll back into the slurry before the drum reaches the apex of its cycle.

The majority of drum filters operate under vacuum. In some instances pressure filtration is required for liquids of high vapor pressure. Continuous pressure filters are considerably more expensive by virtue of their construction. Installation and operating costs of continuous pressure units generally exceed those of vacuum filters. The reverse holds true when process requirements or small volumes dictate batch operation.

Each of the four types of drum filters can be varied in a number of different ways. For instance, filter tanks can be equipped with agitators of various types to prevent segregation of feed solids, submergence of the drum can be varied in an effort to affect cake moisture and types and methods of filter medium support can be altered. Vapor tight or vapor retaining hoods can be provided on vacuum filters for noxious gases and sterile conditions. Another wide variation in drum filters is the method of cake discharge whether it be by scraper, wire, scroll, roll or string.

Perhaps the widest possible variations exist in materials of construction which have run the gamut from wood to plastic, mild steel to various alloy steels, as well as rubber-covered metal.

Disk—In place of the cylindrical drum the disk filter utilizes a number of circular disks mounted vertically on a horizontal, rotating shaft. The disks are composed of a number of removable sectors each of which has a suitable medium support and drainage. To replace the medium, the complete sector is removed and a replacement inserted while the unit is in operation, if desired.

Disk units—primarily of the vacuum type—are commonly applicable to dewatering of cement, flue dust, coal and metallurgical slurries. Washing is generally not practical due to the limited cake drying time and vertical position of the cake. Mechanical agitation may be employed to maintain a uniform suspension of solids in the slurry tank. It is also possible to split this tank so that two products can be handled simultaneously.

The disk unit provides a large filtering area in a minimum of floor space, and initial cost per square foot of filter area is low. Another advantage is the ease of medium replacement. Occasional disadvantages include production of a slightly wetter cake than the drum filter and general impracticality of washing.

Horizontal—The revolving table horizontal filter is perhaps the most widely applied of all horizontals. The filter table is divided into a number of pie-shaped sections. Feed and wash are applied from overhead piping and the formed cake is removed by a scroll discharge which leaves approximately a ¼-in. "heel" on the medium.

Hooded and vapor tight construction is available. A recent development has been the introduction of a pressure operated unit.

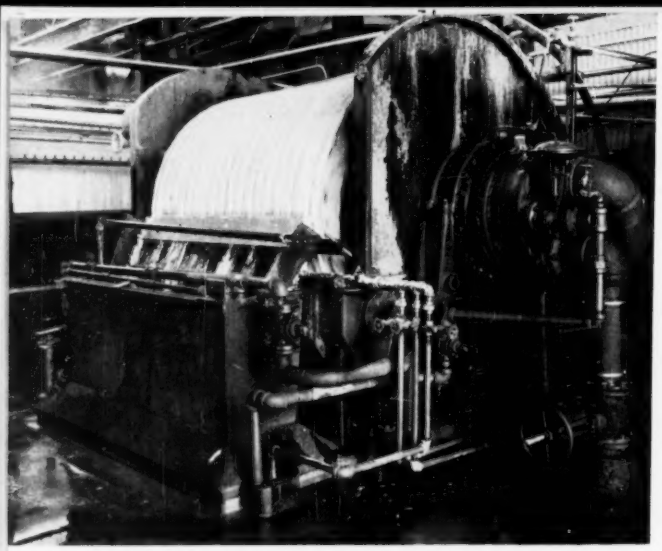
For applications which necessitate complete cake removal, the tilting pan type horizontal is more adaptable than the scroll discharge type. However, the initial cost and floor space requirements of the former are greater due to the extensive mechanism required to turn the pan 180° twice during each revolution.

One of the belt type horizontal filters is a perforated endless rubber belt which is fitted with some form of medium. Slurry is filtered and solids washed as the belt travels between driving sprockets at both ends. Cake is ischarged as the belt makes a 180° turn to start its return trip.

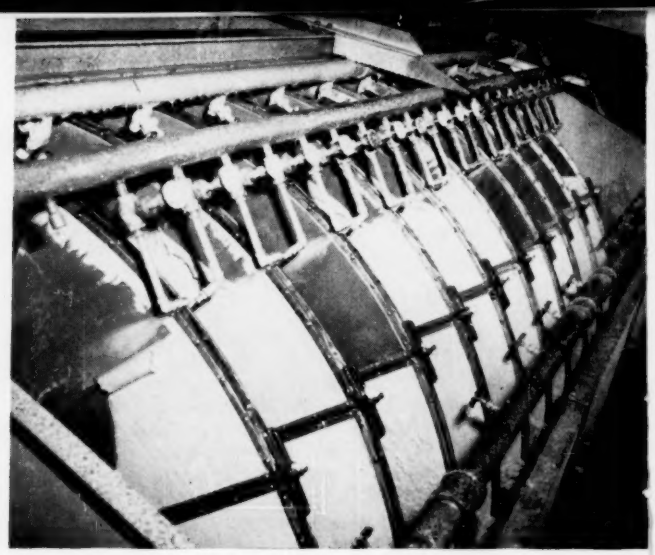
Another belt type filter—the traveling pan type—involves a narrow endless belt upon which is mounted a series of individual rectangular pans, each of which operates as an individual filter. Cake is discharged when a pan is turned over as the belt starts to make its return. During the return trip each pan may be washed by sprays. Major disadvantage of both types of belt filters is the initial cost and required floor space.

The horizontal type filter is one of the newest in the filtration field and its application is not as fully developed as the other types. Primarily it has been used for dewatering and washing operations.

As a rule the horizontal filter is applicable where



DRUM filters are the best known continuous units.



DISK FILTER is recovering fine paper mill fibers.

cake forming is rapid and feed solids are high. Feed containing rapidly settling solids may require a horizontal type filter (or possibly an internal drum) due to the difficulty of maintaining the solids in suspension without segregation in the tank of a drum or disk filter. Use of horizontals permits greater capacities with rapid dewatering slurries and allows cakes ½-in. to 8-in. thick to be formed and washed.

They also often wash cakes more completely than a drum filter. Also, these units are well suited to countercurrent washing of the formed cake and segregation of filtrates of different strengths. This is one of the major advantages of the horizontal over the internal drum filter. The horizontal is more expensive than a drum unit, but capacity is higher on a square foot basis because it handles thicker cakes at higher speeds.

Batch Filters

Leaf—The majority of leaf filters are pressure units, although a few are manufactured to operate under vacuum. Leaves are of all shapes—usually rectangular, but also circular. In operation leaves are totally submerged and filtrate from each leaf is connected to a central manifold. Advantages of this filter are a lower initial investment per square foot of area, generally good washing characteristics and flexibility. Labor costs are usually higher. Downtime for cake discharge may be a costly factor.

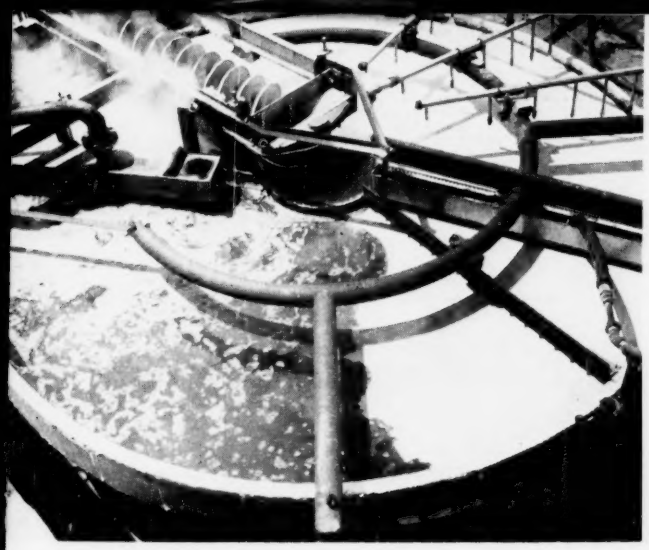
In physical appearance, pressure leaf units range from vertical rectangular leaves in an upright cylindrical shell to circular leaves in a horizontal cylindrical housing. Most are rugged units and the latest and larger designs are capable of either dry or sluice discharge. The current trend is to apply automation to this type filter.

The most familiar vacuum leaf filters operate similar to a plating operation. The leaves are submerged in the slurry and vacuum applied until a predetermined cake thickness is attained. The leaves are then lifted from the slurry vat and immersed in a tank of wash solution where the cake is washed free of solubles. Following this the leaves are lifted, and the cake is discharged by an air blow.

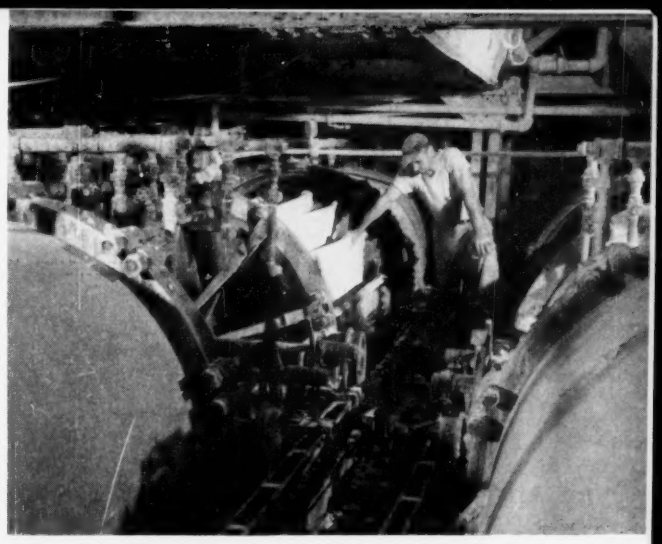
Cartridge—Almost invariably of the pressure variety, cartridge filters have not been widely applied in the chemical industry, although their application is growing. They utilize an inexpensive cartridge or

Typical Applications of the Basic Filters

Continuous Filters			Batch Filters		
Drum	**Disk**	**Horizontal**	**Leaf**	**Cartridge**	**Plate and Frame**
potash	alumina	gypsum	aluminum sulfate	water clarification	caustic soda
nickel sulfate	cement	monosodium glutamate	sodium dichromate	oil	furfural
calcium carbide	pickle liquor	polyvinyl chloride	magnesium hydrate	(not widely used in	gypsum
magnesium chloride	waste waters	potash	aluminum hydroxide	chemical industry)	lithopone
vinyl acetate	coal	sodium ferrocyanide	calcium citrate		naphthalene
gluconic acid	(primarily a	potassium nitrate	glycolic acid		nitrocellulose
ethylene glycol	metallurgical	caustic salt	cellulose acetate		shoe polish
acetic acid	filter)	silica gel	acetic acid		benzene
titanium sulfate		aluminum trihydrate	oleum		camphor
sodium hypochlorite		sodium sulfate	formaldehyde		cellulose acetate
oil		silica sand	sodium sulfate		gasoline
pigments			kerosene		clay
			Fuller's earth		



HORIZONTAL table filter dewaters and washes potash.



LEAF PRESSURE filter operates on a starch slurry feed.

tube which is thrown away when the medium becomes plugged. Obviously, the application to be practical must be on a very low solids stream in which clarification is the objective.

Plate and Frame—The "work horse" of the chemical industry—the familiar plate and frame or filter press—is one of the oldest types of batch filters. It was being augmented by the various leaf type units, so manufacturers redesigned these filter presses. Now frames can be cleaned while the filter is still operating by having two sets of frames hinged from a common axis.

Operation is simple, and wash can be applied, if desired. Major disadvantages are high labor costs, since the cake is removed manually.

Factors Affecting Filter Selection

After considering the various types of filters we should examine the factors which influence filter selection. They include slurry characteristics, cake characteristics and process requirements. Which of the three is most important in selecting a filter depends entirely upon the case in point and upon over-all economics of the filtration operation.

Slurry characteristics involve such variables as the percent solids in the feed, slurry temperature, corrosiveness, viscosity of liquid and particle size distribution. Each variable influences to some extent both the general and the specific type of filter chosen, the materials of construction and the unit's accessories.

Cake characteristics include volume, moisture, compressibility, permeability of the formed cake, and the difficulty or ease of cake discharge and washing. The best method of cake discharge is hard to select, and many continuous filter operations are less than satisfactory because this variable was not properly studied prior to design.

Process requirements remain, perhaps, the major factor in determining the type of filter to be used. Here the degree of filtrate clarity or the purity of the discharged cake, as well as the percent moisture in the cake, is specified. Pressure filters are generally considered where high clarity is desired and low feed solids are present. Vacuum filters are generally considered where good cake washing or low moisture content of the cake is important.

The capacity of a filter on a given product determines the size, number and often the type of filter recommended. Here corrosiveness of the slurry, as well as vapor pressure limitation, must be considered.

Finally, operations preceding or following the filtration step may dictate conditions which may further influence equipment selection. For instance, end use of both cake and filtrate will dictate the desirability and practicality of washing.

Pre-Selection Filtration Tests

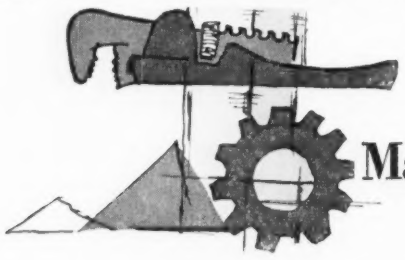
Frequently, some form of testing is necessary before the details of a new filtration installation can be finalized. With the wealth of experience accumulated in solving filtration problems through the years, it would seem that any type of test would only serve the purpose of confirming previously collected data. This is not necessarily true, since modern technology presents us daily with new products to process and for which sizing and design features can be determined only by test. Current prospective applications often require more detailed laboratory study than previously.

The reasons are many. Often process changes alter filtration properties or strict process requirements establish a tough performance goal. But probably the major reason is new and unusual applications as well as products. To illustrate, consider these recent applications which required extensive testing before details of the required filter could be decided: washing cellulose acetate fines to a residual acetic acid content of 0.01%; filtration of lithium chloride in an inert atmosphere to prevent moisture absorption; and separation of explosive lithium hydride from oil at 300 F.

Required tests can be carried out on a laboratory or pilot plant scale, using either the manufacturer's or the user's facilities and personnel. An advantage of the filter maker's laboratory is that he often has many different types of filters on hand, as well as equipment for such complimentary operations as classification, thickening and flotation.

But testing on the larger pilot scale in the user's own plant gives a better chance to observe the entire filtration process and to check the effect on filtration of process changes at other points on the flowsheet. Also, the cost of commercial equipment usually justifies the expense and time of piloting.

SELECT AND DESIGN FOR O & M



Materials Handling Equipment

Bulk materials handling equipment often presents problems in chemical plants. Here are tips for their solution.

T. O. MENARY and H. N. HOWE, Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

Reduced to the most elemental terms, three main viewpoints exist in a production operation: top-level management's, operating supervision's, and maintenance supervision's. These viewpoints vary according to the individual's responsibilities concerning design, selection, operation and maintenance of materials handling equipment.

Top-level management has an overall viewpoint that requires obtaining maximum earnings by developing an optimum balance of investment, operating expense, and maintenance costs. In effect, the owners, through management, furnish materials handling facilities and labor that operating supervision, with the assistance of the maintenance department, must apply most effectively to achieve management's goal.

This article is primarily concerned with the design and selection of bulk materials handling equipment from the standpoint of operation and maintenance. It presents a summary of basic selection principles rather than a description of specific equipment, with primary attention to bulk handling equipment.

Know Your Material's Properties

The specific values of the physical properties of a material under all actual operating conditions must be considered. For example, a material's bulk density in a pile is likely to be different from its bulk density in a screw conveyor, and the fluidity in a vibratory conveyor may bear no resemblance to the fluidity at the discharge of a hopper. A dangerous situation can develop when a material is judged non-explosive in the preliminary analysis but actually becomes explosive due to the type of dust created or aeration which develops during conveying.

A list of the important materials characteristics is given on a following page. Of course, they must be determined under conditions as close as possible to those in the handling equipment.

To avoid the situation of improperly functioning equipment after installation, it is possible to conduct tests which will reveal most of the complications before a final design is made. Many equipment manufacturers have laboratory facilities that are available to customers for test purposes or will place test equipment in the customer's plant.

When the designer must admit to himself that he cannot accurately predict performance, tests are essential. It is more economical to prove the equipment early on a small scale than during production operations. What is suggested here does not preclude the need for start-up adjustments in any new system, however.

How Much Material Is Handled?

Capacity is the most important single factor in the design and operation of materials handling equipment. The term capacity means the capacity range over which the equipment will be operated, both economically and with flexibility for coordinating its operation with other equipment in the system. Therefore the designer should not oversize equipment just to be sure it will have adequate maximum capacity.

An important factor to remember is future additional capacity. Typically the designer can allow for future increased capacity by:

- Including the additional capacity in the original design.
- Designing convertability features in the original equipment.
- Deciding at the outset that replacement or additional equipment should be provided if more capacity is required.

An example of the first case might be designing a screw conveyor for its expected ultimate capacity, but initially designing the drive for a slower speed or for reduced loading. Examples of the second case include the design of hoppers with supporting structures strong enough to support increases in bin height, or the design of a bucket elevator for addition of buckets when more capacity is needed.

Where the number of units in a system can be reduced, economies usually result. To accomplish this the designers should, whenever possible, combine the functions of materials handling equipment and process equipment. For example, where a limited degree of mixing is required, a ribbon flight screw conveyor may frequently serve effectively as a mixer as well as a conveyor.

However, just as conveying equipment can be used for mixing, it may also undo the mixing or other processing that has previously been done. For example, when the conveyed material varies greatly in particle size or weight, free fall through air can cause product segregation.

What to Do About Product Contamination

Conveying equipment should not be a source of product contamination. The following are four frequently overlooked sources of contamination:

• External Corrosion—Besides the material handled the atmosphere through which the conveyor passes sometimes is very corrosive. In most cases protective coatings provide an economical solution, but special materials of construction may be required for this atmosphere.

• Metal Contamination—A major problem facing any manufacturer of a high-purity product is metal contamination. It is the source of many customer complaints as well as a cause of equipment downtime and high maintenance costs.

Where the source of contamination is the conveyor itself—such as nuts working loose and dropping into the product being conveyed—special lock nuts, cottered nuts, or nuts tack-welded in place may be used. Additional protection can be gained from the use of magnetic grates and belt conveyors with magnetic pulleys.

• Foreign Particles—Foreign particles that are non-magnetic or non-metallic require the use of metal detectors or screens. Foreign particles may be from sources other than the conveying equipment The designer should include shielding and equipment covers to prevent material from falling into the conveyor.

• Lubricants—When conveying bulk materials the problem of lubrication is twofold: to supply enough lubrication and to avoid product contamination. Whenever possible bearings that need lubrication should be placed outside the conveyor housing or sealed lifetime bearings or nonlubricated bearings should be used.

Cleaning, Inspection and Breakdowns

Materials handling equipment can be a source of high operating costs if frequent cleaning is required. Quick-access features such as drop-away troughs for screw conveyors, spool sections in pneumatic conveyors, cleanout plates on pneumatic conveyor elbows, and large size access doors in bucket elevator boot casings should always be considered. Designers should also use filleted corners and special surface finishes on equipment where cleanliness is a critical factor in the process operation.

Inspection ports should also be included in any design. When properly placed, they are invaluable for detection of trouble sources and for routine maintenance observations without shutting down the equipment. Pressure taps should be included in pneumatic conveyors to make operating test readings and to locate trouble spots when the conveyor is plugged.

From an operating standpoint, emergency breakdowns cause many headaches; lost production, idle equipment time, and lost labor productivity skyrocket the product's mill cost. Emergency breakdowns cause other equipment to be deprived of regularly scheduled maintenance. Careful design of parts with the highest probability of failure should eliminate all but the freak breakdowns.

Nuisance Problems

Emphasis is being placed on reducing, or at least maintaining, present plant noise levels. One of the major sources of noise is excessive equipment speed. The tendency is to gain more capacity by increasing the speed of present components.

An increase in equipment speed not only raises the noise level, but also lowers the life of the equipment. An example is screw conveyors where wear increases as the cube of the speed. Standards are being developed to assist purchasers by including noise limits in equipment specifications.

Equipment and supporting structures should not obstruct operating areas. Drives and structural supports should be placed so that there is easy access to equipment for maintenance and there are no barriers to block operating aisles or exit paths in emergencies.

Materials handling equipment should not be the source of excessive heat or fumes. Special designs for gas, dust or fume tightness are required when handling toxic materials or materials blanketed by an inert gas. Gas tightness in a screw conveyor, for example, is difficult to maintain. Shaft seals are the greatest problem in designing gas-tight equipment. Poor design of the shaft seal can cause excessive operating costs due to inert gas losses.

Operating Controls

The well-designed conveying system is no better than the controls that govern its operation. Maximum equipment efficiency and the safety of operating and maintenance personnel demand careful selection of controls.

Although many conveyors are controlled manually, most conveying systems have automatic or semi-automatic controls. This discussion of controls deals with the latter.

Controls may consist of a single start-stop push button and a series of interlocks between the drives of the various units. Interlocks provide automatic shutoff of equipment preceding a conveyor that is down, thereby preventing excessive damage and the need for labor to clean-up material delivered to a "dead" section of the conveyor.

Controls should be readily accessible. A stop button at one end of a long belt conveyor is useless to an operator at the other end. An emergency stop cord is sometimes run along a belt conveyor so that the belt may be stopped from any point along its length.

In some types of equipment duplicate controls are desirable. For example, an additional start-stop station should be provided at a bucket elevator's drive platform (usually at the top of the elevator) so that maintenance personnel can control the unit from there.

Materials Characteristics

You need to know these properties of the material you're handling:

- Abrasiveness
- Angle of internal friction
- Angle of repose
- Angle of slide
- Bulk density
- Contamination limits
- Corrosiveness
- Degradability
- Explosive properties
- Flammability
- Fluffiness
- Fluidity
- Friability
- Hygroscopicity
- Melting point
- Stickiness
- Unusual properties

Maintenance—Thorough, Efficient, Easy

New designs should include preventive maintenance features wherever possible. Lubrication is an example. Basically, lubrication can be periodic, lifetime or central automatic. The first of these calls for a preventive maintenance schedule, while the other two may be designed into the system initially.

Operating and maintenance supervision wants equipment that is easy to maintain. Accessibility for maintenance may be considered in two categories:

- Safe and easy-to-reach working positions for maintenance men.
- Quick access into the equipment for maintenance.

The first category is discussed later in the safety section. An example of the second is screw conveyor covers and hand hole covers. A few easily removable hold-down bolts permit the maintenance man to service equipment quickly. The fixed stud with a wing nut, the toggle clamp and other time-saving fixtures may add slightly to the initial cost, but reduced maintenance time can be as important as low purchase price in the selection of materials handling equipment.

Another profitable access feature is the corrosion protection of equipment requiring periodic maintenance disassembly. Where access to parts may be hindered by corrosion, special materials and coatings should be used.

Maintenance men suffer many frustrations and enjoy many personal triumphs concerning non-standard parts. When the boss sends a maintenance man out to a job and tells him it should take only a few minutes, it is a real frustration to find that a special bolt, shim, bushing or bearing is required and is not in maintenance stores. It's a challenge for him to conceive a novel substitute, but it is not an economical maintenance procedure.

There are two solutions to this problem. One is to have complete maintenance stores, but this can be a heavy financial burden. The other solution is to design or purchase equipment constructed mainly of simple, standard parts. An intelligent compromise tending to favor the latter approach is a practical solution.

Another way to get easy and quick equipment maintenance is to have components that are maintained independently or can be integrated into modular units which can be removed to the maintenance area for service. The first case is typified by the outboard bearing and separate shaft seal on a screw conveyor. The seal, which needs more frequent maintenance, is accessible without disturbing the bearing.

Modular units should be considered for components having complex maintenance requirements, so that equipment downtime can be reduced by their quick interchange. Maintenance time and trouble can also be saved if such complex units are removed to the maintenance area where better working conditions usually speed the work.

A good design provides easy equipment assembly and alignment in the field. The equipment designer often does not know in what system the equipment will be installed. He may assume that system installation plans provide access to and support for the equipment he designs.

The systems designer may then assume that the equipment designer has provided for assembly details and components alignment. The result is that the maintenance man is saddled with another problem that must be solved in the field.

Designers should thoroughly consider what installation obstructions may exist and what tools the maintenance man is likely to have available to him. The advantages of intricate or precise designs should be balanced with the need for special wrenches, precise alignments, and adjustment.

Safe Operation Is a Must

After equipment is ready to be operated, the first (and last) step is the actuation of the controls. Their importance in the direct functioning of equipment has already been discussed. Safety considerations are always equal in importance to any other single factor. And it is essential that the design of the control system puts the operator in control of the equipment safely, by indicating to him anything unusual before it becomes critical.

An important safety consideration is the provision of safe, well-planned access to inspection ports, removable covers, safety vents, takeups, drives and the like, for both operators and maintenance men. This includes initially locating components so that they are accessible from the operating floor level or providing permanent or movable ladders and platforms. Frequently during the design stage more and better access aids can be provided for the combined use of operators and maintenance men. The false economy of omitting access aids may become apparent in accident statistics after the equipment is operating.

Serious hazards are not always obvious, even though the existence of noxious fumes, explosive vapors, gases and dust can hardly be overlooked. There are many installations operating today which apparently are "safe" only because chance has not yet brought the critical factors together.

A frequently overlooked hazard is that of static electricity. Briefly, the hazards of the discharge of static electricity are:

• Ignition of explosive atmospheres or flammable materials.

• Shocking of personnel resulting in falls from heights or into machinery.

Static electricity can be generated in a number of ways which are usually evident only to a trained investigator. Static electricity is not always grounded by many seemingly obvious ground contacts. Gaskets, bearing lubricants, corrosion, paint and many other common items can isolate static electrical charges.

All static electrical connections should be included within each unit of equipment. Then only a suitable ground connection to a single fitting is required. A review of the complete system is still necessary because interconnection of units and some dissipation devices for special problems will always have to be considered.

The need for belt guards, gear covers and high temperature insulation to protect personnel is well known. However, from the maintenance viewpoint, safety guards must be easily removed for maintenance inspection, lubrication and repair.

Too often it's felt that the harder a screen is to remove, the safer it is. The unsafe condition of a screen hanging by one loose bracket is the responsibility of the designer as much as of the careless maintenance man. A guard design to be adequate must equally meet the requirements of isolating hazards and allowing safe access for quick maintenance.

Safety guards can frequently be designed to serve dual functions. A gear cover which is also an oil bath reservoir is an example. The service lives of belt or chain drives can be extended appreciably where abrasive dust or high temperatures are present by using the safety guards to exclude foreign materials and heat. This would keep belts, chains, pulleys and sprockets clean longer or preserve the belts or lubricants by shielding them from drying conditions.

A top priority safety requirement is that equipment should fail safely. For instance, better quality electric hoists provide for an electrical component to stall the motor and cut the input power as soon as an overload is detected. Then if the overload is great enough, the hook will open prior to the load being raised and before the rope or its splices break.

With such designs adequate warning of overloading is given and complete failure can occur only in the most extreme cases. This does not imply that the equipment will not be damaged before ultimate failure, but damage during the fail-safe sequence is better than injury to personnel or damage to valuable equipment which the hoist serves.

The equipment designer may not know the design of the complete system in which his equipment will be used, but he should provide fail-safe features in individual components or units of equipment. Illustrations of these features are the overload cut-out provisions on conveyor drives, and the backstops to prevent reversal of a loaded conveyor in the case of drive failure.

Fail-safe features to prevent complete system damage should be provided. An example is controls to automatically stop a conveyor feeding a hammermill when tramp metal is detected in the material on the conveyor.

Maintenance men have developed procedures over the years to protect themselves, such as monitored start-up sequences and latches on switches requiring padlocks for each craft concerned. More equipment and systems designers should acquaint themselves with the techniques the maintenance men have proven in use. Then they can incorporate features in their designs both to increase the safety benefits and to simplify the precautions. An example is the design of power and control circuits so that large, modular sections of systems can each be de-activated by one disconnect rather than by many individual switches. And the whole system need not be shut down at the main switch for safe maintenance.

Checklist

Equipment Requirements for	O	& M
Enough production capacity	P	
Adequate controls	P	
Runs without being coddled	P	
No degraded or contaminated materials produced	P	
Quiet running	P	
No obstruction of operating areas and passages	P	
Enough inspection ports and access doors	P	P
Easily and quickly cleaned	P	S
Minimum emergency breakdowns	P	S
No source of excessive heat, fumes, dust, etc.	P	S
Adaptable to preventive maintenance programs	S	P
Easily and quickly maintained	S	P
Safe to operate and maintain	P	P

P—primarily concerned
S—secondarily concerned

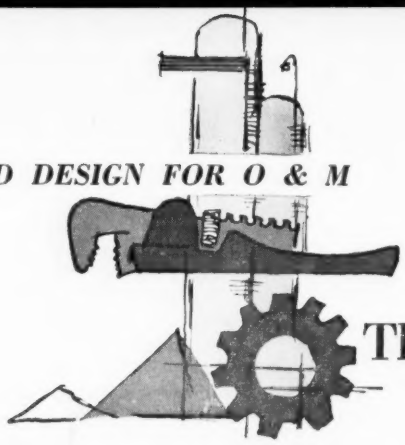
Checklist of Equipment Features for O & M

The accompanying table summarizes the chief requirements for a materials handling system from both operating and maintenance standpoints. The more of these considerations your equipment meets, the better designed will be your system.

Conclusion

Sound theoretical design of materials handling equipment is a basic, essential requirement. The value of materials handling equipment can be reduced if those who design and specify equipment are not fully aware of the many limitations imposed by the practical needs of operation and maintenance.

Finally, design and selection criteria must include a proper balance of the economic factors of mechanical design, operation and maintenance.



SELECT AND DESIGN FOR O & M

Thickeners and Clarifiers

Rules-of-thumb in selecting thickeners and clarifiers can help you avoid operating and maintenance headaches.

GLENN O. WILSON, Director, Industrial Technical Div., Dorr-Oliver Inc., Stamford, Conn.

While sedimentation, as a process, may be "old hat," the equipment as we know it today is new. In selecting equipment to carry out this operation, general design for area, depth and capacity aren't the only criteria to take into consideration.

What type to select and why, can often be decided by the operating and maintenance characteristics. What type of drive should be used? Is corrosion a factor? What raking mechanism is best?

Here then, is a review of the equipment and the how and why so you can "Select and Design for O & M."

What Is Sedimentation?

Before examining the details of present-day equipment, we should consider some of the basic aspects.

Sedimentation is divided into two distinct operations: thickening and clarification. Thickening is an operation to concentrate the solids of a liquid-solids suspension into a denser slurry. This emphasis on the solids phase gives minimum consideration to the liquid fraction. As a result, the liquid usually contains a measurable quantity of suspended solids.

Clarification, on the other hand, involves the production of a clear liquid overflow with minimum concern for concentration of the settled solids.

In some operations, both aspects of sedimentation are equally important and it's possible to accomplish both economically in a single unit of proper design. In these instances, however, the results of one or the other, or perhaps, both operations aren't as good as when emphasis is placed on just one phase of sedimentation. Typical of this is treatment of a plant waste for the simultaneous clarification of process water for re-use and the recovery of solids.

Sometimes, combining both phases in a single unit is particularly undesireable. For example: in sewage treatment, clarification of raw sewage should be carried out separately from thickening of the settled sludge. Here, the nature of the material being handled is responsible for the poor results when the two phases are combined.

Thickeners and Clarifiers Differ

Thickeners are constructed more ruggedly than clarifiers because of the differences in their assigned tasks. It stands to reason that a heavier duty mechanism is required to handle slurries containing 60 to 65% solids than to handle the same material at 10 to 30% solids.

The nature of the solids enters into the picture also. You can't expect a mechanism designed to thicken a flocculent pulp such as water coagulation sludge to work equally as well on a heavier viscous hydroxide sludge. Nor can you expect to see a heavy-duty metallurgical mechanism in a water treatment plant.

On a general basis, thickening and clarification equipment are similar. There are a few types of each that don't have a counterpart. For instance, a rectangular, drag-type clarifier is unsatisfactory for thickening while a heavy-duty traction-type thickener is just too big and rugged for any clarification job.

Sedimentation units can be grouped into two basic types: single and multiple compartment units. Within each of these groups there are a number of basic variations based upon both size and specific application.

Single Compartment—Most Used

Single compartment machines, without question, are the most broadly applicable, widely used and economical sedimentation units. A major provision here being sufficient area available for the unit.

It's made up of a shallow cylindrical or square tank with a bottom sloping toward the center. The entire area is swept by slow-moving arms with attached blades that are oriented to rake deposited solids inward to a central discharge point.

Liquid overflows a peripheral weir or launder near the top of the tank. Feed is introduced through a centrally located feedwell that reduces streaming of feed directly to the overflow launder.

Single compartment units can be subdivided, depending on the mechanism support, into center-shaft and center-pier units. In the center-shaft, the walkway, feedwell, drive, raking mechanism and vertical shaft are all supported by two parallel steel beams or trusses spanning the diameter of the tank. Raking mechanism consists of two radial arms, 180 degrees apart.

To prevent damage to the mechanism during periods of overload, some form of warning device and method of raising the arms is necessary. This can range from a manual operation to automatic devices that hold the mechanism up until the load is reduced.

Diameters of center-shaft units run from 6 to 60 ft. However, in recent years a number of larger units, up to 120-ft. across, have been designed and constructed. These have found particular application in the uranium industry.

In the center-pier type of sedimentation unit, the mechanism is supported by a stationary pier of steel or concrete rather than by beams or trusses. Units of this type start at 30 ft. and go all the way up to 325-ft. dia.

To provide necessary overload protection, the center-pier is designed with a hinged-rake construction that allows the arms to raise automatically when excessive overload is encountered. The raking arm, triangular in shape, is pinned to the center cage at two points. By allowing the third contact to remain unpinned the arm can be raised for the entire period of the overload.

As continuous raking action reduces the load, the arms gradually resume normal operation position. This unusual protective device makes it practically impossible to stall or damage the unit.

Once again, two raking arms are usually provided. However, depending upon the characteristics of the solids, these arms may number as many as four. In such an arrangement, two long arms sweep the outer areas of the tank while two additional shorter arms scrape material closer to the center of the basin. With the hinged-rake feature, each arm lifts independently of the others. There are times when three-armed machines are also used.

Drives Are Important

Driving of the units discussed so far is accomplished by an internal gear train located above the central cage and feedwell. This method of driving becomes increasingly difficult as tank diameters increase. Therefore, a special heavy-duty machine called a traction thickener operates in extremely large diameter tanks handling heavy metallurgical pulps. Its main application is in 200 to 325-ft. dia. tanks that are beyond the size limits of centrally driven shaft and pier-type sedimentation units.

In traction thickeners the main raking blades are attached directly to a radial driving truss supported at the center of the tank. At the periphery the truss is supported by two traction wheels that run on a rail mounted on the tank wall. Each raking truss is driven independently on the periphery rather than from the center. Mechanical advantages of this type of drive are obvious.

Center-pier, shaft and traction units are widely used in the chemical and metallurgical industries for thickening. The first two are also used as clarifiers and in water and waste treatment. Unit compartment clarifiers also find chemical applications in the pulp and paper industry and with certain metallic compounds that are light, fluffy or of a flocculating nature. Since the traction unit is for heavy-duty work, its use as a clarifier is uneconomical.

Variety Is Available for Selection

Variation in sedimentation units is attained not only in the sizing but more important in strength or torque capacity of the driving mechanism.

Units of a specific size can be selected with a variety of driving mechanisms, each rated to handle a predetermined maximum load. Once the size of the unit is set, the physical characteristics of the solids must be analyzed so the proper size drive head can be selected. It's uneconomical to purchase a unit with a massive drive to handle feathers. But, on the other hand, you're gambling when you select a drive head insufficient to properly do the job.

It's most advisable to be guided by a manufacturer's recommendations and experience.

Square-Shaped Clarifiers As Well As Circular

For clarification applications, the basic center-shaft and pier mechanisms can be adapted to square tanks. Mechanism support is identical to circular units.

Major difference is equipping one of the rigid raking arms with a special pivoted corner blade to reach into the four corners of the tank. Action of this blade must be both positive and automatic so that settled sludge is removed from the corners during each revolution.

A second variation is in the method of feeding center-pier machines. It can be from a central feedwell, just as with circular units or from a cross-flow type of operation where the feed is introduced along one entire side of the tank and overflow is taken off the opposite side. This cross-flow type of design is particularly good in an operation where flocculation is carried out in basins, immediately adjacent to the clarifier.

In all other respects, design and operation of square clarifiers is identical to circular units.

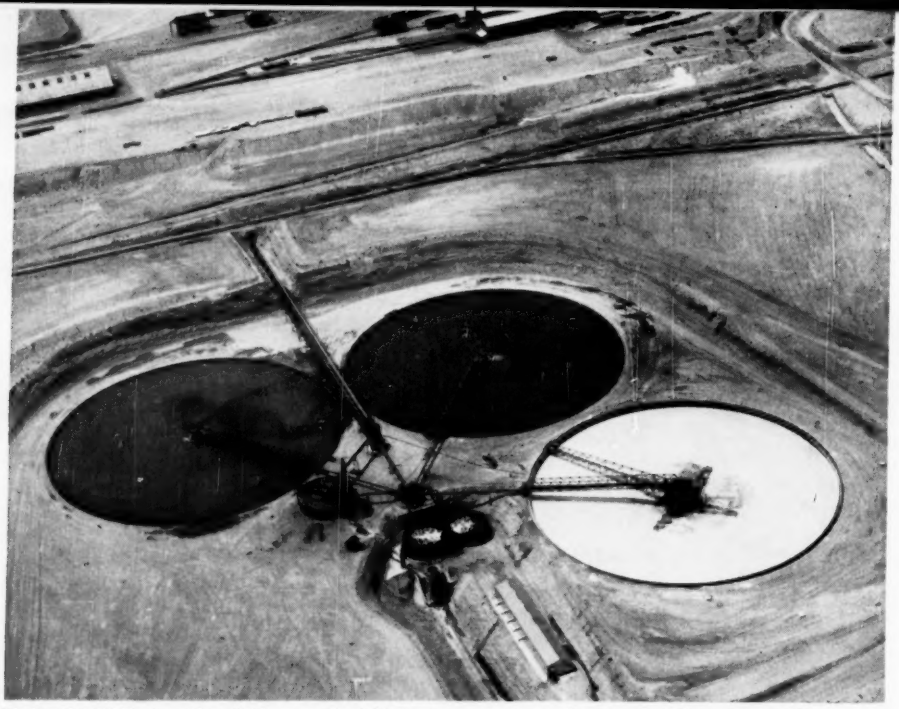
Another type of clarification mechanism is designed to fit long narrow rectangular basins. This is used almost exclusively in the sanitation field. Raking blades are either supported from a bridge or carriage spanning the clarification tank or carried by two endless chains running the length of the tank. In any case, settled solids are raked to one end of the basin for discharge.

Drive of the bridge clarifier is accomplished by parallel steel cables connected to a mechanism that's either stationary or carried on the bridge. Rectangular tanks have been built as large as 300-ft. long and 100-ft. wide.

A fourth type is a combination "upflow" unit used primarily in water conditioning. Here, clarification is accomplished and feed solids are filtered upward through a sludge blanket.

Multiple Compartments: For Limited Space

Where floor space is limited and ample head-room available, multiple or tray type sedimentation units



THREE 325-ft. traction thickeners installed at a copper production facility. (Dorr-Oliver)

can fit in well. Major applications have been in pulp and paper, cane and beet sugar and to some extent in alumina manufacture.

Tray units consist of a number of shallow, superimposed settling compartments, usually a maximum of 40 to 60 ft. in diameter. Each compartment is equipped with a raking mechanism attached to a common rotating shaft. Feed, overflow and underflow arrangements vary according to the material being treated and the specific method of operation.

These units are operated in any of three ways. In the first, all feed enters the top compartment and is distributed equally to the other compartments through an annular opening around the central shaft. Overflow is removed from each compartment. Underflow is raked to the central opening of each tray where it joins the feed going to the compartments below. Accumulated sludge gradually works its way to the bottom compartment where it is thickened further and discharged.

Using the balanced-tray method of operation, each compartment is individually fed and overflow from each is removed separately. Solids settled in each of the compartments are discharged by gravity into the compartment below through a central down-cast boot that extends below the bed of sludge in the next lower tray.

Trays are therefore sealed and mingling of sludge and solution is prevented. Depth of sludge in each compartment is regulated by raising or lowering the height of the overflow column. This column is balanced by the sludge bed as in a U-tube.

In washing-type tray units the compartments operate in series with feed entering the top compartment and solids progressing downward. At the same time, wash water enters the bottom compartment and flows upward, counter-current to the solids. Integral with the sludge seal is a down-cast boot that projects into the next lower compartment and serves as a mixing well. Wash solution enters the well to re-pulp and dilute the settled sludge before being thickened again.

This type of unit is especially adapted to small counter-current decantation operations handling hot solutions. It requires little floor space and can be easily insulated.

A combination tray unit is also available where one or more settling trays in parallel are followed by a series of two or more washing trays. As many as five compartments can be included in a single tank.

Materials of Construction Meet Needs

Sedimentation units are normally constructed of mild steel, concrete or wood. In special cases where corrosive solutions are handled you can specify stainless, lead-lined or rubber-covered steels; Duriron; Pioneer metal or bronze. For acid-resisting duty, wooden tanks may be lead-lined.

In general, manufacturers of sedimentation units will supply equipment fabricated of almost any material required by your specific application and within recognized construction limitations.

Standard trays for multiple compartment units are usually fabricated from $\frac{3}{16}$ or $\frac{1}{4}$-in. steel plate and arranged for welded construction. When necessary, trays are suitably reinforced against upward pressure. Steel tanks are generally provided with manholes for access to the compartments.

Some Rules for Selection

After area and depth requirements have been determined, your next job is to select the most efficient and yet economical sedimentation unit. While certainly no hard and fast set of rules can be established, a few rules-of-thumb help in general guidance.

- If floor space is limited, consider the tray-type. It provides the greatest capacity per unit of floor space occupied.
- If you have to conserve heat, the tray-type is

best. It's easily covered and insulated and permits the smallest temperature drop between feed and overflow.

• If the amount of underflow solids is extremely large, you should look into the traction-type since it gives the greatest raking capacity per unit of area. As power is applied at the end of a long raking arm, deeper and larger plow blades can be used with other types of units.

• If periodic overloads are frequent and severe, a torque type or some form of automatic self-raising and lowering arm lifting device might fill your needs best.

• If at all possible, you should use a single compartment, central-drive unit when corrosion is a factor. Portions of this unit below the liquid level are economically constructed of special materials.

• When finely divided solids are thickened, a baffled flocculation nozzle should be used to discharge the feed from the feed ring. This is so a rolling action is given to the feed that promotes flocculation and aids in settling the solids.

• Overflow weirs should be absolutely level to insure a steady and uniform sheet of overflow liquid. Any irregularity in weir level will cause a convergence of flow at the low points. The velocity may be so high at these points that fine solids can be carried over that have been caught in the current.

• Outlets should be large enough to take care of maximum overflow rates.

• In large tanks installed outdoors, a saw-toothed or notched weir will overcome the effect of the wind. With a perfectly level weir, the wind may force most of the effluent to overflow at one side.

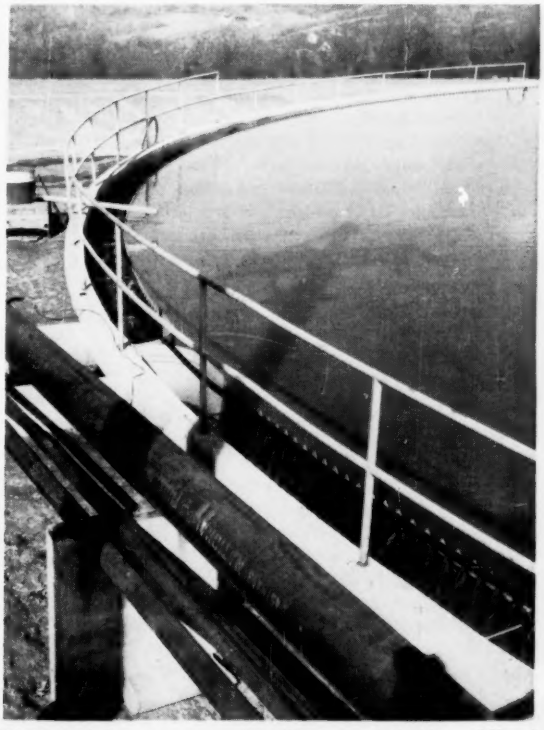
There Are Many Applications

One of the most prominent uses in the chemical industry is in continuous counter-current decantation of finely divided solids to free them of liquids containing dissolved substances. Chemical precipitates, ground metallurgical ores and residues from leaching operations are commonly treated in these plants.

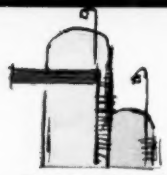
Purpose of this operation is to attain a high degree of separation of soluble materials from solids with a minimum number of decantations and a minimum of wash liquid.

Solids being washed move in a direction countercurrent to the wash solution and are progressively depleted of soluble material by coming in contact with larger and larger amounts of soluble materials. Efficiency of the system depends on removing settled solids from each thickener with the least amount of solution and on the thoroughness of re-pulping sludge and wash solution between stages.

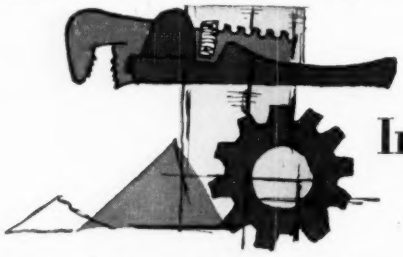
PICKETS help increase solids concentration. (Dorr-Oliver)



WEIR notches overcome the effect of wind. (Dorr-Oliver)



SELECT AND DESIGN FOR O & M



Improve Agitator Performance

Adequate design of fluid agitators assures efficient mixing and provides easier maintenance at lower cost.

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In the modern chemical plant the agitated vessel, agitator and auxiliaries may represent 5% of the total plant investment. Annual maintenance expenses on some difficult operations may run as high as 20% of the installed cost.

Actual maintenance costs may be many times this value if production downtime and consequent production losses are included. Thus, we can justify substantially increased investment to insure the best performance.

Any agitator accomplishes its intended mixing operation by doing work on or putting energy into the fluid. However, the desired results are obtained only when the energy has the proper intensity, is of the proper quantity and is properly distributed throughout the liquid.

Pressure, temperature, vapor pressure and corrosivity of the fluid are the minimum basic data necessary. These enable the designer to select the required materials of construction, establish type of seal and with process specifications calculate bearing thrusts, analyze stresses and compute critical speeds.

The individual agitator components are shown in Fig. 1. We usually analyze the components as follows: impeller, shaft, coupling, seal, drive and drive supports. Let's examine these components closely.

Factors to Consider for Impeller Design

The impeller converts electrical or mechanical energy into fluid energy. Fluid energy appears as either shear or flow. While there are no tricks to the mechanical design, the magnitude and non-uniformity of hydraulic loading can cause mechanical difficulties.

Hydraulic load, hydraulic balance, strength, mounting, ease of assembly and disassembly, ease of removal from tank, weight and static and dynamic balance must be considered for optimum design.

An acceptable method for figuring hydraulic load is to assume that all the power available at the prime mover will be dissipated in the fluid and that the load will be shared equally by each of the impeller blades. A parabolic load distribution along the length of the blades provides a basis for calculating stresses.

Under some operating conditions hydraulic balance can be a prime requisite. Laboratory tests and plant experience demonstrate that certain impellers transmit power less uniformly to the fluid than others. Such impellers have a tendency to weave during normal operation. If this weaving is excessive, premature failure of the shaft or drive may occur. Two-bladed paddles, for instance, are of the unbalanced type and exhibit this tendency noticeably. For this reason four or more blades normally are recommended.

Standard formulas and normal design procedures for dynamically loaded cantilever beams plus attention to good welding practice at the hub usually are sufficient. However, since the impeller blade bends, twists and vibrates a great deal, practice indicates that induced stresses may be at least twice those calculated by the usual methods. Investigate vibration and fatigue, particularly at the hub, for long blades.

Normally, a hub length at least equal to the shaft diameter assures squareness of impeller with shaft. With low torque and a light-weight impeller, two set screws spaced 90° apart around the shaft may give satisfactory service. However, at higher loads a key must be used to transmit the torque. A taper pin, threaded on one end and held in place by a nut may be used to position the impeller.

Ease of assembly and disassembly is very important. Difficult working conditions due to cramped quarters, leaky valves, hot surfaces, poor ventilation and corroded bolts make disassembly a nightmare if the design is not right. Tapered bores, split hubs, through bolts and other special features can be used.

When the removal port is small, separable blades as shown in Fig. 2 can be used to provide easy removal from tank. The hub should be small enough to pass through the mounting nozzle, or it may be of split construction to facilitate dismantling.

Minimum weight consistent with required strength will save material, facilitate handling and result in a system with a higher critical speed. Weight can be saved by using low density material, stronger materia', blade with cross section tapered from hub to tip, partial blade on center disc and box construction.

Balance every impeller statically. Unbalance creates an undesirable centrifugal force which may bend the shaft. Static balance can be achieved rather simply by placing the shaft supporting the impeller on knife edges, and making weight corrections.

In most normal applications, speed is sufficiently low so that static balancing is adequate. At very high

speeds dynamic balancing may be needed. Allowable unbalance which depends upon speed is specified as allowable eccentricity. This is the distance between the center of gravity of the impeller and its axis of rotation.

When the impeller is subjected to unusual hydraulic exciting forces, as during draw-off of fluid from the vessel, provide for damping the induced vibrations. This can be done by employing a more rigid system or by using a suitable stabilizing device under the impeller. One type of stabilizer, a circular ring, is shown in Fig. 2. Here the stabilizer functions by providing increased lateral drag on the system.

Factors Affecting Shaft Performance

The agitator shaft transmits power from the prime mover to the impeller. Materials of construction, straightness, finish, deflection at seal, run-out at seal, run-out at end of shaft, critical speed, strength, and corrosion allowance must be given due consideration.

Common shaft materials used in the chemical industry are carbon steel and stainless steels. Occasionally monel, nickel, aluminum, bronze, titanium, Hastelloy and coatings such as glass, lead or rubber are used.

There are no satisfactory published standard tolerances for straightness of shafting. A straightness tolerance of 0.001 in./ft. accumulative for the length of the shaft is sufficiently accurate. Consideration should be given to stress relieving where machining or operating conditions warrant.

If high speed operation is contemplated, dynamic balance of the shaft assembly should be considered. Because individual components may be replaced during maintenance, it is preferable that each component be balanced prior to final balance of the assembly.

Use turned, ground and polished bar stock where possible. Manufacturing tolerances of this form of shafting will be suitable in most cases for mounting impellers and couplings. Surface finish of this bar stock will be satisfactory to use through stuffing boxes.

Where a seal is required, allowable deflection of the shaft at the seal point usually dictates shaft diameter. Allowable magnitude of the deflection depends upon the process requirements and type of seal. For rigorous leakage control the maximum allowable deflection may be as little as 0.002 in. The value of actual deflection can be lowered by reducing the load on the impeller, increasing shaft diameter or reducing shaft length.

Since the agitation system is an optimum design from the process standpoint, each change involves a process compromise. Before a change is made consider:

- A different impeller at the same speed or same impeller at a different speed may reduce the load, but may result in longer mixing time or adverse process effects.
- Increased diameter of shaft may result in increased cost for all the agitator components.

Alternate considerations are bottom entering or side entering agitators where sealing requirements can be met. Mechanical run-out of the shaft at the seal can cause seal operating difficulties. It is necessary to hold this factor within tolerable limits.

Critical Speed Is Important

One of the most important considerations in shaft design is critical speed. These are the speeds corresponding to the natural frequencies of the shaft system. It is important because most mechanical troubles with mixers result from excessive vibrations. These vibrations can cause permanent bending or fatigue failure of the shaft, damage to the seal or drive or even failure of the tank and supports.

Conventional formulas for calculating critical speeds provide values for operation in vacuum. Although operation under vortex free conditions in a liquid may cause damping, this effect should not be assumed in design. In many cases, calculations based on impeller weight, over-hung shaft length and materials of construction are sufficient. Here, we neglect the effect of the supports if they are sufficiently rigid.

In other instances the shaft configuration between the bearings and flexibility of bearing housing, agitator support stand tank, and tank supports have considerable influence. There are some installations where the flexibility of these members is great enough to lower the critical speed significantly.

Some of the major factors affecting critical speed are impeller weight, shaft weight, shaft length, moment of inertia of shaft, and modulus of elasticity of shaft material. Increases in the critical speed can be effected by using tapered, stepped or hollow shafts. Such special shapes can be of considerable help, but should be used only where the increased engineering and manufacturing costs are justified.

Operation preferably should be below the first critical speed, but where conditions necessitate, speeds above first critical may be used. Actual plant experience has shown the following to be reasonably safe operating limits.

For operation below first critical speed with hydraulic balanced type impellers, use operating speed less than 75% of first critical speed. If the impeller is of the unbalanced type, use operating speed less than 40% of first critical speed.

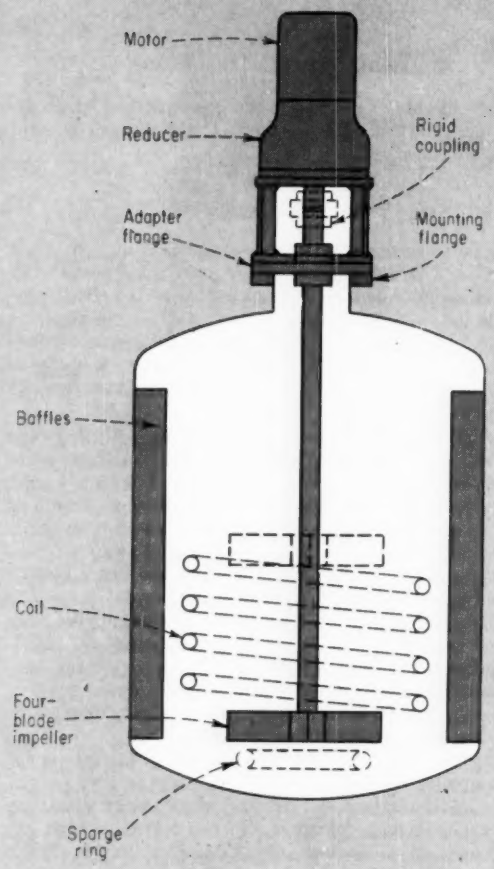
For operation above first critical speed with hydraulic balanced type impellers, use operating speed greater than 120% of first critical but below 65% of second critical speed. The agitator should be dynamically balanced. If the impeller is of the unbalanced type, do not use above first critical speed.

When operating above the first critical speed, acceleration and deceleration of the agitator during start-up and shut-down should be sufficiently rapid to minimize operation in the critical speed zone. If the inertia of the system is high, provide braking or damping devices and high starting torque motors.

While it is generally recognized that dangerous vibrations can occur when operating at the first or

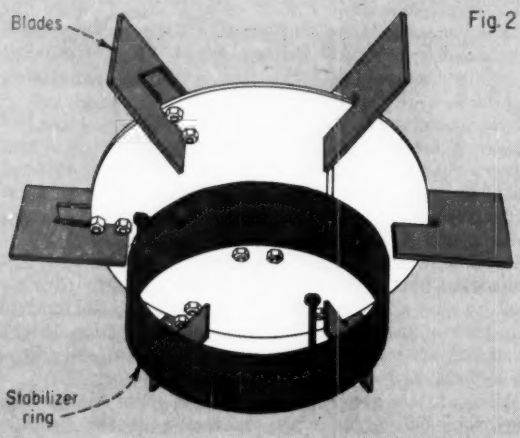
Typical Components for Agitated Vessels

Fig. 1



Separable Blades Aid in Removing Agitator

Fig. 2



higher critical speeds, it is not widely known that secondary vibrations of lesser degree can occur at operating speeds of one-half the first critical speed. Similar phenomena are also possible if the fundamental frequency of a disturbing cause is any simple fraction of the natural frequency.

Another important factor in the design of the agitator shafting is strength. Usually, either critical speed or allowable shaft deflection will dictate a shaft so large that shaft stress levels are of little consequence. Allowable stresses dictate shaft diameter when static run-out and dynamic deflection are not acute and operating speeds are low.

Both the shear stresses due to torque transmission and the bending stresses due to the unbalanced hydraulic forces on the impeller must be evaluated. The combined stresses are maximum in an overhung shaft near the lower bearing. Therefore, the shaft must be strongest at that point.

Shaft Seals Provide Product Protection

Shaft seals separate the external atmosphere from the tank contents. Toxic and valuable materials may leak out or dirt and oxygen may leak in to damage the product. A vast number of different types of seals are used. Whatever the type seal selected, maintenance aspects are a paramount consideration in the choice.

Repairs, labor and materials and production downtime are found to be disproportionately high. Wide temperature variations, pressure fluctuations, corrosive and erosive action by chemicals and fluids all work against good performance. If the shaft is perfectly round, has an ultrafine finish, and runs dead true, maintenance is easier.

Here are some of the more common seal types: dust seal, liquid seal, stuffing box and mechanical seal. Piston rings, O-rings, bellows, labyrinths and a number of other devices are also sometimes used.

Provide Suitable Drives for Agitators

Equipment arrangement as well as process requirements dictate the type of drive system.

Tank geometry, location of tank nozzles, location of the tank with respect to building beams, and ability of the tank to support the drive system can affect mechanical performance and ease of maintenance. For example, support of a drive on a tall and slender tank may be impractical due to a high center of gravity induced by the weight of the drive or due to lack of available headroom.

A large number of nozzles on the tank head may limit the drive selection to the vertical in-line motor reducer. Limitations of tank strength and building layout may require bottom entering agitators.

Required agitator speed, horsepower and impeller position influence shaft size and length and thus may dictate drive selection. Special process considerations such as multi-purpose units may necessitate use of a variable speed drive. Direct coupling of motor and agitator may be possible when high speed units are required. In the majority of cases, the agitator speed

is less than the speed of the prime mover, and a speed reducer is necessary.

For high speed operation pneumatic, hydraulic and electric vertical motors can be coupled directly to the agitator shaft by either a rigid or a flexible coupling. Directly connected drives usually are limited to high speed, high shear operations and to propeller type mixers requiring relatively low power.

A rigidly coupled system requires the prime mover shaft and bearings to be adequate for the loads imposed by the agitator. Although the shaft and bearing design of the prime mover may be adequate for the torsional and bending stresses encountered during normal rated duty, additional loads imposed by the agitator frequently necessitate the use of a larger shaft diameter. Thus, definite limits of power and shaft length are placed on the rigidly coupled installation using standard drive motors.

Avoid the use of special drive motors with oversized shafts or special shaft material because of high initial cost and poor replacement potential.

A flexibly coupled system is used for in-line coupling of a standard prime mover to an agitator shaft which is supported by separate bearings. With this arrangement the motor can operate at rated duty under normal service conditions without additional bearing loads imposed by the agitator. If the agitator shaft has a separately mounted bearing housing, a standard motor may be used with V-belts, chain drive or timing belt.

Low speed operations require a prime mover and a speed reducer. Prime mover may be mounted directly on the speed reducer or separately supported and flexibly coupled. Experimental units and some plant applications require variations in speed. Air motors, multi-speed electric motors, gear change boxes, eddy current couplings, hydraulic motors, fluid couplings, D.C. drive, and variable pitch pulleys can be used.

Four types of speed reducers commonly used for agitators are the right angle worm gear reducer, vertical in-line motor reducers with either helical spur gear or planetary gears, gear motors and spiral bevel or combination helical and spiral bevel gear reducers.

Before deciding which reducer will best meet requirements, certain basic design features such as bearing span, noise and lubrication should be considered. Circumstances may dictate the use of special three-bearing assemblies.

Extra wide bearing spans are of no advantage and are not justified for agitator applications. In most cases, the shaft diameter required to satisfy other agitator requirements will determine the bearing size. These bearings should have ample capacity for all normal agitator applications. An increase in bearing span increases shaft deflection at the seal and will lower critical speed. Furthermore, deflection between reducer bearings may adversely affect the gear performance.

Over-all noise level of agitator drives must be considered. This is particularly important where multiple close confined drive systems are necessary.

Selection and application of suitable lubricating media will be determined by the type of gear system, loads involved, and operating temperature. A constant controlled supply of lubricant to bearings and gears is absolutely necessary. Enclosed gears usually are lubricated with oil by one of three systems: (1) oil circulated by pump to all bearings and gear trains. This system permits use of heat exchangers for cooling and installation of oil filters; (2) dip lubrication for gears with separate lubrication system for bearings and (3) combination of dip and forced feed.

Reducers with shafts in vertical down position should have lower output shaft bearing mounted in a dry well to prevent oil leakage down the shaft. The lower bearing is normally grease lubricated. Design and type of grease seals should be carefully considered as they are often a source of trouble.

Where closed tank operation requires the use of a mechanical seal that can be replaced without removing drive, a spacer type shaft coupling may provide the necessary axial clearance for seal removal. However, this may locate the bottom bearing of a gear reducer too far from seal to maintain run-out within acceptable limits. It may be possible to lower the bottom bearing adjacent to the seal to minimize run-out, but this will mean an increase in reducer bearing span resulting in shaft deflections that may damage reducer gears.

Under these circumstances it may be necessary to consider a three bearing assembly. In this arrangement two main permanently aligned bearings in the gear reducer locate the shaft, with a third or lower bearing mounted adjacent to the seal in a manner that will permit compensation to be made for inherent machining and assembly errors. This method of support must be carefully designed for ease of assembly and disassembly while maintaining alignment.

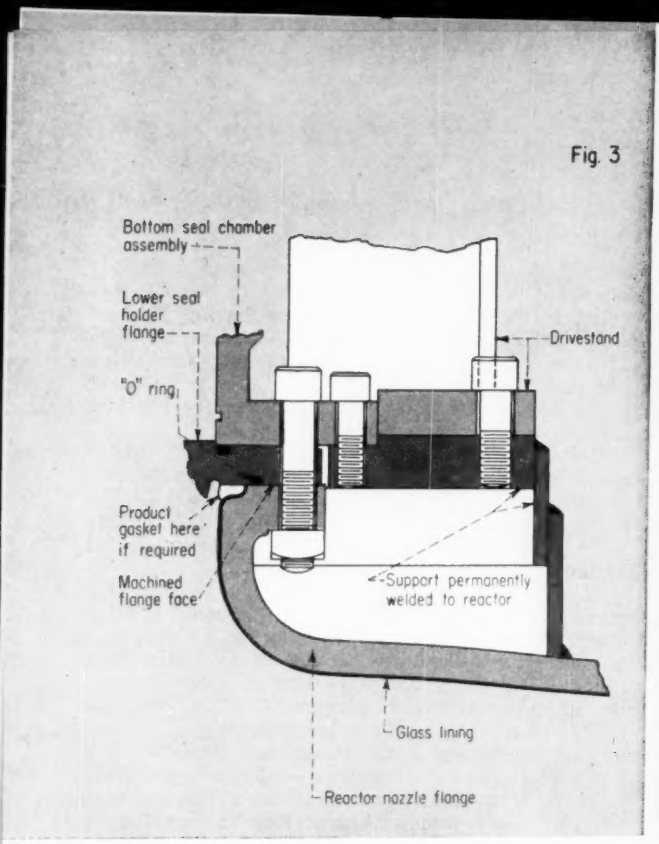
Correct alignment of a three bearing assembly presents many difficulties. Misalignment introduces additional shaft stresses and increases the reactive load on the bearings. While the amount of misalignment dictates the magnitude of additional loads, there is no easy way to determine just how much misalignment exists. Good design may help to reduce alignment errors, but manufacturing techniques and operating conditions can introduce additional effects even in a well designed unit. For these reasons two bearing arrangements are preferred.

Other important factors are gear ratings, type and layout of bearings, rigidity of gear housing, accessibility for repair or inspections, size, and distribution of weight.

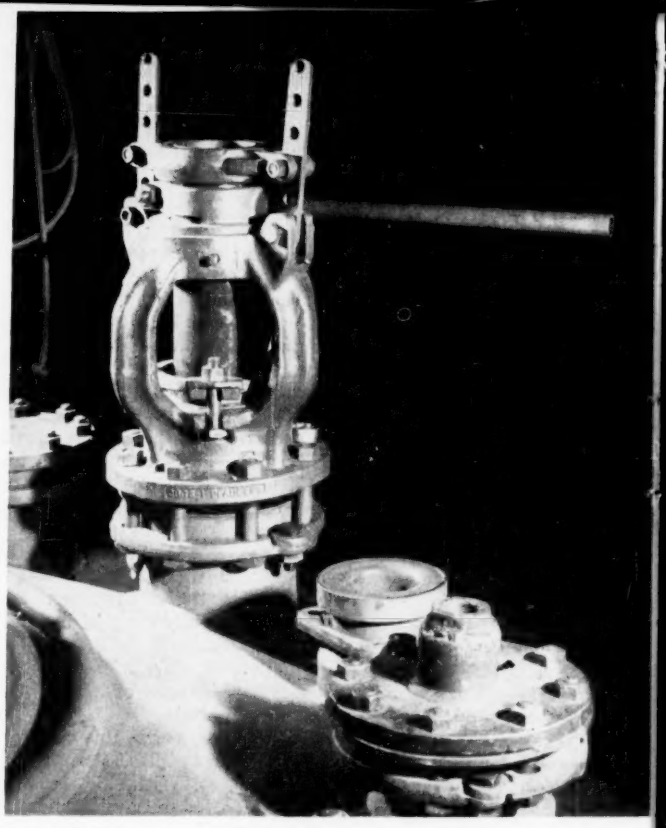
Adequate Support of Agitators Is Essential

Main supports for the agitator assembly vary in design from one to another, but practically all such supports can be classified either as tank mounted or non-tank mounted.

Direct tank mounting generally is effected through a stand which contains the seal and maintains its alignment with the two shaft support bearings. The agitator drive rests on the stand, and the stand in turn is bolted to the tank on a suitable mounting pad or nozzle. The stand must be strong and rigid. Variations in its design are required depending upon the type of seal used and the location (inside or outside



SUPPORT distributes agitator weight over greater area.



NOZZLE-MOUNTED baffle support, Fig. 4.

the tank) of the coupling. The direct tank mounting support is widely used for closed tank installations where the tank contents must be sealed.

In special cases such as glass-lined vessels where deflections of the tank head must be held to a minimum, nozzle mounting is undesirable. In these cases the weight of the agitator must be distributed over a greater area of the tank by attaching additional supports directly to the vessel. Such an arrangement is shown in Fig. 3.

Individual supports are used when the agitator is so large that it is impractical to use the tank for support. Special tank construction such as masonry, wood or thin metal walls also preclude direct tank mounting. Open tank operations usually require individual supports although in many instances beams supporting the agitator are run across the open tank and fastened to the walls of the vessel.

Design considerations of proper supports are strength, rigidity, alignment of components and accessibility for maintenance. Strength must be sufficient to support the agitator weight and resist the moments produced by unbalanced hydraulic forces at the impeller. Rigidity must be great enough so that the critical speed of the agitator shaft is not lowered appreciably and so that vibrations of the agitator are adequately damped before transmission to the tank or building steel. Natural frequencies of the supports should be in the order of ten times the agitator operating speed.

Alignment of the components can be maintained if mating faces of parts are doweled or provided with rabbet fits. Under these circumstances the shaft can be made to run true in the seal with consequent improvement in performance. Sufficient clearance should be provided for the use of service aids to facilitate repacking, tightening and alignment for maintenance purposes.

Internal Fittings Affect Agitator Action

Agitators auxiliaries are defined as the internal tank fittings which affect the performance of the agitator. All such auxiliaries are subjected to the forces of the flow produced by the agitator. The forces and resulting stresses will vary depending on the agitation intensity, proximity to the agitator, and shape and construction of the fitting concerned. Internal fittings influencing agitator design and performance are baffles, coils, draft tubes, feed pipes, sparge rings, steady bearings and stabilizers.

Baffles are used to eliminate swirl and secure top to bottom interchange of material. Thus, they must be strong enough to resist the forces of the moving liquid. One method of estimating this force on the baffles is to assume that agitator torque is transmitted to and equally distributed over the wetted area of the baffles.

Baffles may be supported on the vessel wall by welding, bolting, or the use of clips. Clip mounting will permit baffles to be offset from the wall. In glass, wooden, or lined tanks it may be preferable to support the baffles from nozzles in the tank head. A typical design for a nozzle mounted baffle support on a glassed vessel is shown in Fig. 4.

Supports should add stiffness to the baffles to preclude build-up of vibrations excited by the flowing liquid. Such excitation can be reduced by avoiding uneven combinations of baffles and impeller blades.

Support of coils by baffles or other vessel attachments must be carefully considered. In all cases coil design and support should allow for thermal expansion or contraction. Looseness in supports will permit coils to vibrate against other vessel fittings, and can eventually cause fatigue failures of feeder pipes and coils. Provision for coil removal or repair must be made.

Where draft tubes are used they must be designed for ease of assembly within the vessel. Supports should allow adjustment in both vertical and horizontal planes. Ample clearance between draft tube bore and impeller should be provided.

Feed pipes, thermo-wells, dip legs and spargers must be designed and supported to withstand drag forces from the liquid, and must be positioned to clear all rotating elements.

In-tank bearings are seldom used in the chemical industry because the environment in the agitated vessel is not conducive to good bearing performance. These bearings can be located at the top of the tank, at bottom of tank or at any intermediate position. Such steady bearings allow use of smaller diameter shaft because smaller spans mean less stress, less deflection, higher critical speeds, and less vibration during operation.

Steady bearings are poor investments because corrosive fluids, non-lubricating fluids, alternate wetting and drying, low speeds (no hydrodynamic film), abrasive solids, and alignment difficulties do not lead to good lubrication nor good performance. External lubricants under pressure may contaminate valuable product. A maintenance free steady bearing is nonexistent and bearing seizure or excessive clearance is inevitable.

Servicing of a steady bearing involves shutting down agitator, closing and locking all valves to tank, emptying tank, washing and ventilating tank under plant safety regulations. Servicing also requires providing mechanics with approved personal safety equipment and tools. If a steady bearing must be used, it should be easily accessible for maintenance and provided with means for aligning the replacement bushing with the shaft.

A typical steady bearing is shown in Fig. 5. If the legs of a bottom steady bearing are straddled over a vessel nozzle, it is possible to replace shaft sleeve and bushing from outside the tank. Use of an adjustable bushing holder permits alignment from outside of tank.

In the past agitators and all their components were designed by the user, fabricated by a number of suppliers and assembled by the vendor or the user. Gradually, some standard components became available and were incorporated into assemblies by the user. Recently some manufacturers supply complete agitator assemblies. This step has been beneficial and experience indicates that savings can accrue from:

Decreased design work or repetition.

Decreased manufacturing costs via production of standard components.

Decreased installation expense through pre-assembly.

Development of improved mechanical design by manufacturers.

Improved operating and mechanical reliability resulting from proven design.

Reduced spare parts inventories because fewer models are more readily available.

Lower training costs for maintenance personnel.

If full values are to be realized from the use of packaged agitators, the purchaser must continue to exercise his engineering responsibility.

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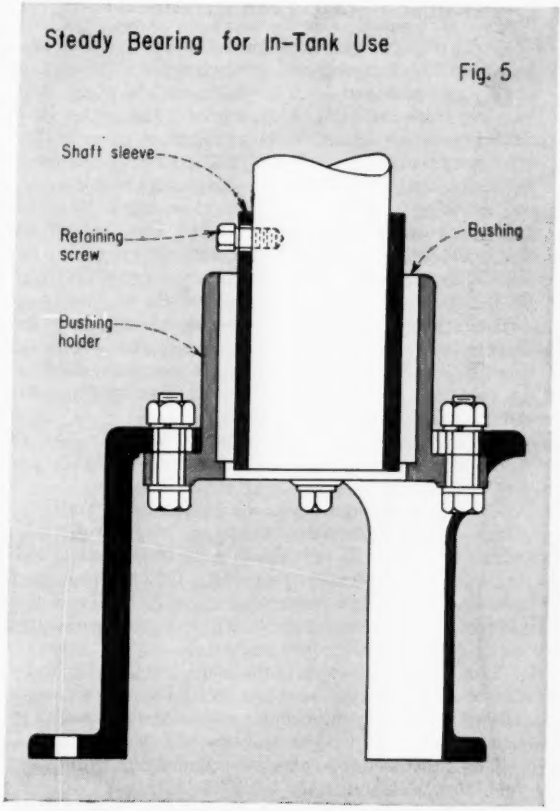
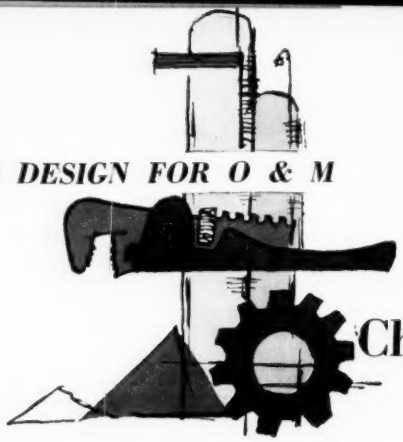
Steady Bearing for In-Tank Use

Fig. 5





SELECT AND DESIGN FOR O & M

Chemical Process Pumps

The ubiquitous process pump is reviewed briefly, and an O & M checklist of pump troubles and causes is given.

R. R. RHODES, Asst. Manager of Sales, Standard Pump Div., Worthington Corp., East Orange, N. J.

Can you imagine a chemical plant without pumps? Yet as common as they are, pumps are too often sources of operating problems and high maintenance costs. To help you make better pump selections, we present here a glance at some types of pumps, a few typical selections and a summary of major pump operating problems and their causes.

To select a pump, an engineer must consider the conditions and type of service, the kind of driving force available, the initial cost, and, quite thoroughly, the operating and maintenance requirements and costs.

Centrifugal—Most Popular

A centrifugal pump imparts velocity to a liquid by centrifugal force, and is therefore a velocity machine, as compared to the reciprocating pump which is a pressure machine. Liquid enters the center or eye of the rotating impeller, is accelerated in velocity, is moved radially outward into the volute or casing and then discharges through the discharge nozzle.

The single-stage, double-suction, split case centrifugal pump is used widely in the chemical industry for plant water, cooling water and non-corrosive service. It is available in discharge sizes from 2-in. up to 66-in. or larger, and is normally made of cast iron or bronze. For corrosion resistant materials, it is quite expensive because of its size and the complicated casing sections. Therefore it is not normally used in corrosive chemical service. Its two stuffing boxes are also drawbacks for this use.

Multi-stage pumps are chosen primarily for high discharge heads and because they are reliable under high-pressure, high-capacity conditions.

The vertical turbine pump is usually a multi-stage pump. It is sometimes called a "deep well" pump, which describes its principal use in the chemical industry—deep well water pumping. Often these pumps are used on cooling towers pumping either from a well or from a suction chamber. The pumps commonly are made of iron and bronze materials.

The vertical wet pit chemical pump is usually a single-stage pump, and is available in machinable alloys such as iron, bronze and stainless steel. It is used where stuffing box leakage is a problem.

The most reliable corrosive chemicals pump is the end-suction, separately coupled unit. Why is it so widely used?

- It's simple and rugged.
- The working parts are readily accessible.
- It's available in most of the machinable alloys, some non-machinable alloys, ceramics, carbon, plastics, rubber-lined and plastic-lined.
- There is only one stuffing-box to seal.

Rugged simple construction is the key to low cost maintenance with the end-suction pump. Materials of construction are expensive so size must be kept down.

The type of pump is selected partly because of the required service conditions. For example, a pump is needed to circulate cooling water at 50 gpm. and 100 ft. head for air conditioning a plant administration building. A 1-in. close-coupled iron pump with a bronze impeller probably would be picked.

But if the same conditions were required for cold concentrated sulfuric acid in the plant, you would choose a stainless steel pump of the end-suction type, separately coupled.

Why the difference in selection? The water pump would be close-coupled because of its lower initial cost. On separately coupled pumps, damage to the pump shaft or bearings does not require changing the motor, an advantage in a pump handling acid.

The water pump would have an easily cast bronze closed impeller, which has a slightly higher efficiency than the open type. But the acid pump requires a stainless impeller, which is easier and cheaper to cast as an open rather than a closed impeller.

The water pump stuffing box sealing can be a soft packing or a simple rubber-bellows type. The acid pump would have an external mechanical seal with a Teflon shaft seal because of the corrosive acid.

O & M Selection and Design Factors

Probably the most important part of an end-suction pump is the shaft and bearings. Don't think that the biggest shaft is the best; this isn't necessarily so. The important factor is shaft deflection.

Shaft deflection for an overhung impeller in an average volute-type casing is maximum at shut-off. In general practice the maximum accepted shaft deflection is 0.005 in. Next to the size of the shaft at the stuffing box, the length of the shaft from the impeller to the radial bearing is the most important dimension. This latter distance is called overhang, and it should be kept as low as possible.

Disadvantages of a shaft larger in diameter than the optimum are:

- Higher cost.
- Higher rubbing speed in contact with packing. This is a linear relationship. The rubbing speed for a 1.5-in. diameter shaft, for example, at 1,750 rpm. is 686 ft./min. If the diameter is increased to 1.8 in. and the speed is constant, the rubbing speed increases to 823 ft./min.
- More expensive mechanical seals and stuffing box.
- Limited choices of packing lubricant. Frictional heat of higher rubbing speeds melts most ordinary lubricants.

Packing and seals are an important consideration in selecting pumps. As the packing must run cool, there should be provision for an independent liquid seal to the stuffing box. Otherwise the lubricant burns the packing, and the packing (usually asbestos) scores the shaft.

In a modern centrifugal pump it has generally been found that pressure breakdown occurs over the last ring or two of packing. Why put 10 or 12 rings of packing in the stuffing box? A disadvantage is that overhang is increased, which increases shaft deflection and gives poor packing operation.

Mechanical seals must be selected carefully. They are used primarily on clear liquids although with proper treatment they can handle slurries.

The pump should provide a means of cooling both the seal gland and a chamber around the seal. Normally only seal gland cooling is required. However, for temperatures around 400 F. cooling of the chamber around the seal is desirable. This prevents heat from damaging the seal and prevents heat transfer back to the radial bearing.

On corrosive service a shaft with sleeve construction is undesirable because it is difficult to seal the joint between the shaft and sleeve. Not only can corrosion be a problem, but leakage underneath the sleeve can be mistaken for leakage through the packing. An operator may tighten the gland to reduce this leakage. This will cause heat formation, deterioration of the packing and scoring of the sleeve.

In small pumps the sleeve is as expensive as the shaft, so a solid shaft is more desirable. On large pumps the sleeve is economical and can be used.

Reciprocating—Best for Certain Uses

The reciprocating pump operates on the principle of an alternating increase and decrease in the volume of the pump body or casing. This action causes liquid entering the suction of the pump to be discharged at a higher pressure.

Common types of these pumps are the direct-acting steam pump and the power pump. These can be either piston or plunger types. A special pump widely used in the chemical industry is the diaphragm pump.

All these pumps operate on the basic principle that liquid is drawn into a chamber and forced out at a higher pressure by some driving force. The pumps have a pulsating output that may be partially smoothed out by using multiple cylinders.

Materials of construction are limited somewhat due to the moving parts in contact with each other and to the complex and bulky castings. Normally these pumps are made of cast iron, steel and bronze. Stainless steel or special alloy fittings are employed but care must be taken to prevent galling. In general the complete liquid end of a pump is not made of stainless due to the high cost of a very special casting.

The diaphragm pump finds wide use in the chemical industry because it is available in stainless steel as well as synthetic rubber, plastics and almost any machinable alloy. These pumps are even made with ceramic casings and valves.

Diaphragm pumps can be operated mechanically or by air, steam or some other hydraulic fluid. They would normally be selected where packing can not be tolerated or where the liquid is very toxic, corrosive or expensive.

The direct-acting steam pump is the oldest of the modern pumps. It finds use where steam is available for such services as boiler feed pumps, auxiliary pumps, hot oil pumps, etc. Where low-pressure process steam is required, these pumps are used because very little of the heat is removed from steam driving the pump. The pressure is reduced but the heat content is still available for use in process heating.

Power pumps are used in the chemical process industry mainly in the synthesis of plastics, the handling of certain volatile liquids where vapors present problems with a centrifugal pump, and the injection of streams into high pressure processes. The small power pump of the plunger type—sometimes known as a proportioning pump—is used to feed small amounts of materials into a process. Here the definite flow pattern can be used for accurate metering.

Some advantages of reciprocating and direct-acting steam pumps are that they are simple, self-contained units with low maintenance costs.

Reciprocating, and especially steam, pumps are quite simple in design. Selection frequently reduces to choosing the pump for a certain capacity and head (pressure), the type of valve, and the materials of construction.

For example, if a small boiler feed pump was needed to feed 45 gpm. of water at 200 psi. the selection might be a 6 x 4 x 6 duplex steam pump. A disk valve would be used. If the pressure were over 450 psi. a wing valve would be used. If a viscous liquid or an abrasive slurry is pumped, the ball valve would give better service.

If pH is around 7, bronze should be a suitable material for valves and liners. For pH values of 8-11 and 4.5-6, use a chrome steel for valves, liners and rods.

If the conditions called for injection of ½ gpm. of caustic at 100 psi. into a system, the selection would be a small power pump (proportioning pump). A steel forging would probably be used for the liquid end.

Causes of Pump Difficulties

Centrifugal Pumps

Fails to discharge	1, 2, 3, 4, 5
Starts, then loses prime	4, 6, 11
Not up to capacity	2, 3, 4, 6, 7, 8, 9, 10
Outlet pressure too low	6, 8, 9, 11
Takes too much power	9, 12, 13, 14
Pump vibrates	7, 15, 16, 17, 18, 19, 20, 21

Rotary Pumps

Fails to discharge	1, 5, 23, 24
Starts, then loses prime	6, 22, 23
Not up to capacity	2, 3, 6, 22, 24, 27
Takes too much power	3, 18, 25, 26, 28
Noisy	1, 6, 18, 22, 24, 25, 26, 27

Direct-Acting Steam Pumps

Fails to discharge	1, 4, 8
Not up to capacity	29, 30
Pump short strokes	28, 31, 32, 33, 34
Piston strikes head	32, 35
Pump vibrates and pressure fluctuates	15, 28, 31, 36

Key to Causes

1—Pump not primed
2—Pump speed too low
3—Required system pressure too high
4—NPSH too small
5—Wrong direction of rotation
6—Leaks in suction line or stuffing box
7—Impeller partially clogged
8—Pump parts worn
9—Impeller damaged
10—Foot valve too small or clogged
11—Air or vapor in the liquid
12—Speed too high
13—Dynamic head too low, pumping too much liquid
14—Liquid has different sp. gr. and/or viscosity than pump designed for
15—Misalignment
16—Foundation not rigid
17—Shaft bent
18—Rotating elements binding
19—Worn motor bearings
20—Pump dry, wearing rings rubbing
21—Cavitation
22—Liquid vaporizing in suction line
23—Suction pipe not immersed in liquid
24—Suction strainer clogged or too small
25—Coupling or belt drive out of alignment
26—Pipe strain on pump casing
27—Relief valve chattering
28—Packing too tight
29—Low steam pressure or disproportioned pistons
30—Worn packings or poorly packed pistons
31—Air or vapor in pump
32—Incorrect steam end adjustment
33—Steam leakage past valve to port
34—Insufficient lost motion in valve gear
35—Excessive lost motion
36—Valve and suction line losses

Valves would be stainless and of the ball type. Water would seal the stuffing box and cool the packing.

In many processes the materials must be fed to a reactor at high pressure. A typical application is 50 gpm. at 1,000 psi. of a chemical which is not highly corrosive. In this case the vertical triplex pump would be selected. If the liquid contains any grit or abrasives, then ceramic plungers would be used. Wing valves or double-ported valves are commonly used on pumps of this type. The liquid end would be steel forgings, and the valves would probably be stainless steel.

Rotary—Solves Some Tough Problems

The rotary pump is a positive displacement pump which creates a cavity as it turns from the suction to the discharge forcing the liquid along. In the chemical process industries the major rotary pumps are gear pumps and screw pumps.

The rotary pump has low entrance losses and close clearances which permit it to run under very tough suction conditions and to handle viscous liquids.

These pumps are essentially self-priming, but because of close tolerances rotary pumps shouldn't be started completely dry as metal to metal contact results.

Rotary gear pumps can handle viscous liquids such as molasses or asphalt very efficiently. When selecting a pump for such liquids, pick large discharge and suction pipe diameters so that the friction loss is low. Also reduce the pump speed to get less friction loss and to fill the displacement spaces with liquid.

Rotary pumps are frequently used on the following liquids: glue, ink, molasses, asphalt, cellulose acetate, paint, and many oils and hydrocarbons. Some of these liquids are not normally thought of as good lubricants. But since they move through the pump fast and provide rapid circulation through the bearings, they do a good job of lubricating.

Some of the operating problems that can be solved by proper selection of the rotary pump are:

- If the liquid is not a lubricant or contains small amounts of abrasives, select a pump of suitable construction (renewable wear plates) and follow with a regular maintenance program, particularly on bearings.
- If the liquid tends to solidify on cooling, select a steam-jacketed rotary pump.
- If lubrication of the pump is extremely difficult, a pump in the past would have been selected with external bearings. Now renewable wear plates and regular maintenance is the answer.
- If liquid is very hot or under high vacuum the stuffing box packing could be a problem. For such service, consider the use of a suitable mechanical seal.

In general the maintenance of a rotary pump requires adjustments for wear since the pumps operate with very close clearances; any gritty or abrasive materials will cause wear. The sideplates can be cleaned and original clearances restored to give better pump performance, or replaceable wearplates may be used. This is true only of large rotary pumps since the small ½-in. or ¾-in. iron or bronze rotary pumps are largely expendable.

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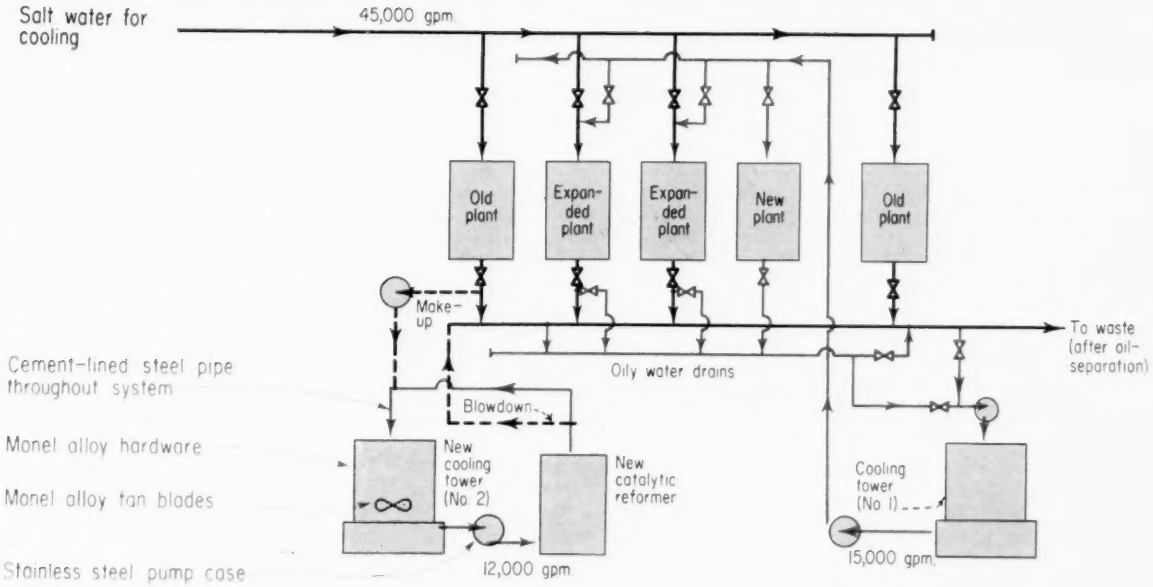


Short of fresh water?

Use Salt Water Cooling Towers

New tower design features promise to lick corrosion problems. Capital costs are 65% below direct cooling from water source.

W. W. MITCHELL, Eng. Dept., Standard Oil Co. of Calif., San Francisco*

Faced by a lack of fresh water at its Perth Amboy, N. J., refinery, The California Oil Co., a subsidiary of Standard Oil Co. of Calif., is providing cooling water for its 10,000 bbl./day catalytic reformer in an unusual way. Working under an appointment from The California Oil Co., Standard's Engineering Dept. analyzed the problem and prepared the basic plans for using a salt water cooling tower (the refinery's second such installation) to supply a required 12,000 gpm. of cooling water.

Why Salt Water?

The reasons for the unusual venture—the units are believed to be the only salt water cooling towers in the chemical-refinery process industries—are necessity and economics:

- A lack of fresh water in sufficient quantity to supply make-up water for a fresh water cooling tower. Salt water cooling towers are economical only where fresh water is not available in suitable quantities.
- The high costs involved in supplying salt water cooling water directly from primary sources. Considering the distance of the process plant from the water source and the need for oil separation from the disposed water, it was estimated that the cost of pumps, lines, and separators would have run about 65% more than a salt water cooling tower system.

The decision to use a salt water cooling tower was strengthened by the successful operation of the company's first installation built over 1½ yr. ago. In 1956, The California Oil Co. installed its first salt water cooling tower, a 6,000 gpm. unit furnished by Fluor Corp. In 1957 this system, known as Cooling Tower No. 1, was expanded to 15,000 gpm. by addition of a unit furnished by Foster Wheeler.

Refinery Expands

California Oil Co.'s refinery is located at the mouth of Woodbridge Creek directly across Arthur Kill from Staten Island. The refinery facilities originally acquired were supplied by cooling water pumped from Woodbridge Creek. When the refinery was expanded in 1950, the new, considerably larger plants required a substantial increase in cooling water capacity.

* Meet your author on page 207.

As the temperature of the water in Woodbridge Creek had risen to a summer high of about 95 F. due to discharge of hot industrial waste water upstream, a new salt water pumping station was built on Arthur Kill to supply the 35,000 gpm. of cooling water then needed. The old pumping station has since been used primarily for supplying water for the fire-fighting system.

Further expansion of the refinery up to 1956 had increased the demand for cooling water to the 45,000 gpm. maximum capacity of the Arthur Kill salt water station. At this time a thorough study of the cooling water system considered expanding the existing system, as well as the possibility of providing a salt water cooling tower. The costs of expanding the salt water booster system, enlarging the line system, and providing additional separators far exceeded the costs of a salt water cooling tower system.

In considering the use of a salt water cooling tower the satisfactory operation of two such towers by the Nebraska Public Power System at Lincoln, Neb. was taken into account. These installations included a 34,000 gpm. unit built in 1950 to cool salt ground water from 96 F. to 83 F., a 13-degree approach to the design wet-bulb temperature. A smaller tower had been in operation since 1930.

Design data were also obtained from the Gulf States Utility Co. of Beaumont, Texas, which was then planning to put into operation its 57,500 gpm. salt water cooling tower to cool Neches River water from 112 F. to 92 F., a 12-degree approach to the design wet-bulb.

The Enginering Dept. of Standard Oil of Calif. has for many years been interested in the development of the use of salt water cooling towers. From their work the first applications in 1956 were developed.

Tower Design for Salt Water

The new catalytic reformer requires 12,000 gpm. of cooling water. Make-up water for the recirculating system will be taken from the salt water system leaving the process plants before being discharged into the oily water disposal system.

Cooling tower blowdown is sent to the oily water disposal system. Make-up water will comprise about 13% of the water going to the cooling tower. With a 3% rate of evaporation, this will result in a 30% increase in dissolved and suspended solids. Since the water from Arthur Kill contains 20,000 to 25,000 ppm. of dissolved solids, the cooling water from the tower will still contain a less amount of dissolved solids than normal sea water. This is not regarded as a limiting value, and the high rate of make-up is used only because water suitable for make-up is abundant. Treatment of the water has not been found necessary in the first cooling tower, and is not expected to be required in the new installation.

The new cooling tower is being designed and furnished by G. W. Galloway Co. It will consist of induced draft counter-flow redwood cooling tower cells similar to fresh water cooling towers except for modifications to further reduce drift (windage loss) and some differences in materials.

Five cells, each 30 ft. x 36 ft. in plan dimension, are designed to cool the 12,000 gpm. from 115 F. to 82 F., a 5-deg. approach to the 77 F. design maximum wet-bulb temperature. Specifications limit the drift to a maximum of 0.1% of the flow to avoid salt water corrosion of adjacent facilities, and it is anticipated that the drift will be 0.02%.

To limit drift loss, the following design features will be included:

1. Air velocity through the cooling tower and through the fans will be kept to a minimum.
2. Height of the plenum chamber (over 8-ft. deep) will be greater than usual.
3. Drift eliminator blades will be closer to horizontal than in conventional towers.
4. Drift eliminators will be sloped to gain distance between the distribution system and the drift eliminators.

These features result in a tower 60 ft. high above the basin top.

Materials for New Tower

Experience with the original tower, which followed specifications for the use of silicon bronze interior hardware, has led to the use of all Monel alloy hardware within the new tower. In general, other metal parts such as gear, motor and fan cases, and drive shafts are Heresite coated. Fan blades and laminated disk assemblies of the drive coupling are Monel alloy.

Two 6,000 gpm. centrifugal motor-driven pumps will take suction from the tower basin and circulate the water through the catalytic reformer and back to the top of the cooling tower. An identical turbine-driven pump will serve as a spare. Make-up water will be pumped into the return header by a 1,600 gpm. horizontal certrifugal motor-driven pump having a second motor-driven spare. Blowdown will be taken from the return header ahead of the make-up water stream and will be controlled by a level controller on the water in the cooling tower basin.

All pumps will have stainless steel cases, stainless steel impellers and Monel shafts. Stainless steel cases and cast iron Lithgow-lined cases were used in the first tower installation and both have given satisfactory service to date. Selection of the stainless steel cases for the new tower pumps was based primarily on lower initial cost.

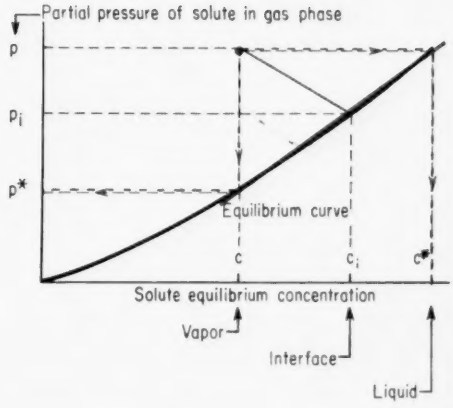
All cooling water lines will be cement-lined steel pipe. Experience has shown that the roughness coefficient, C, for use in the Chezy or Hazen-Williams formulas for computing pressure drop is about 90 in the refinery salt water lines.

The cooling tower basin will be 9 ft. deep to provide reserve water capacity in the event make-up water is lost. All anchor bolts, screens, and other metal items which will be immersed in the basin will be Monel alloy. The redwood cooling tower posts extending into the basin will be creosoted to protect against the possibility of attack by marine borers. The basin itself will be constructed of dense 4,000 psi. concrete using Type II, sulphate resistant cement.

Cooling Tower No. 1

The California Oil Company's first salt water cooling tower system differs from newly planned No. 2. All the water to the No. 1 tower is pumped from the oily water disposal system and the water from the tower is pumped into the existing cooling water supply headers serving several refinery units. Since the water blends with the larger supply from the salt water pump station, the tower is only partially recirculating.

When phase composition shifts as it does in gas absorption, design calculations depend on concentration change. Therefore it's important to know . . .



How to Modify Mass Transfer Equations

JAMES O. OSBURN, State University of Iowa, Iowa City, Ia.*

IN THE refresher series until now, we have discussed mass transfer between two phases. For simplicity, we assumed that the phase compositions were constant.

In mass transfer operations, the phase compositions are usually not constant. The very process of mass transfer causes a depletion of solute in one phase and an increase in the other.

Therefore, when making equipment design calculations, we must modify the mass transfer equations to take these concentration changes into account. Now we'll demonstrate the use of mass transfer coefficients for equipment design in which phase concentrations vary.

How Concentration Varies in Gas Absorber

As an example, consider a gas absorber in which solute is absorbed from a gas stream which is rich in solute. The solute is absorbed in a liquid which flows down countercurrent to the rising gas.

Let's look at the situation at the bottom of the absorber. At this level, the rich gas is in contact with liquid which has become enriched during its passage down through the absorber. One of the products produced is the rich liquid. The concentrations of the liquid and gas streams are as shown in Fig. 1 (next page). The composition of the gas phase is represented by its partial pressure.

As the gas rises, solute is transferred out of the gas phase, leaving a lower concentration in the gas phase. The concentration decreases until it reaches the desired lean gas composition, which is also that of the gas leaving the absorber. Meanwhile, fresh or lean liquid enters the absorber at the top and acquires solute as it flows down countercurrent to the gas stream.

In Fig. 1 we show typical conditions at the top, bottom and at an intermediate section of the absorber. The curve through the three points on the pressure-concentration diagram represents conditions at various positions throughout the equipment.

Transfer Depends on Equilibrium

Our illustration (see above) shows the equilibrium curve for the hypothetical system in the absorber. If the absorber is at constant temperature, we use an isotherm. If there is a temperature variation, it may be possible to correlate the temperature with liquid composition. We then plot an equilibrium curve corrected for temperature.

The equilibrium curve shows the partial pressure of solute in a gas phase which is in equilibrium with a liquid phase of a given composition. Corresponding to the liquid and vapor compositions c and p at any level in the absorber, there are three equilibrium values which may be of interest. As shown in the illustration above, these are the equilibrium liquid composition, the interfacial composition and the equilibrium vapor composition.

If there is resistance to mass transfer in both

* To meet your author see *Chem. Eng.* Mar. 24, 1958, p. 169.

How Concentration Varies in Gas Absorber

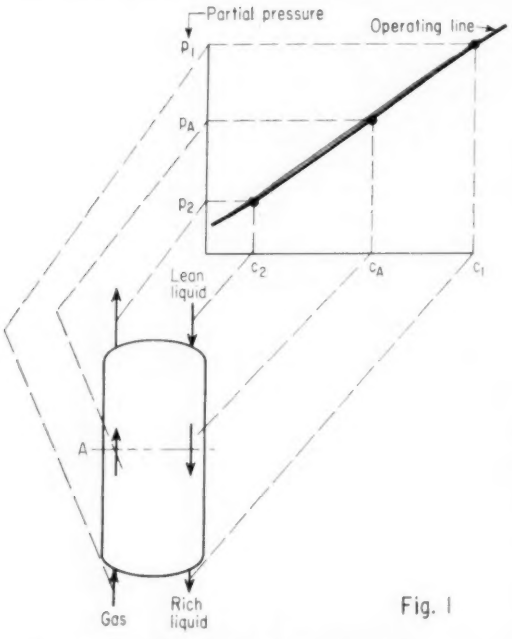


Fig. 1

c = Liquid concentration at section A, lb. moles/cu.ft.
p = Partial pressure of solute in gas at section A, lb. moles/cu.ft.
sub 1 Conditions at bottom of absorber.
sub 2 Conditions at top of absorber.
sub A Conditions at any intermediate point.
G' = Solute-free gas, lb.moles/sq.ft.-hr.
L' = Solute-free liquid, lb.moles/sq.ft.-hr.
M = Molecular weight of liquid.
Π = Total pressure.
ρ = Density of liquid.

phases the interfacial concentrations will be in equilibrium but different from the concentration of either phase. The symbols for these compositions are p_i and c_i.

The equilibrium vapor composition p^*, is the vapor composition which is in equilibrium with the liquid. When the gas film controls, the driving force is $(p - p^*)$. The equilibrium liquid composition c^*, is the liquid composition in equilibrium with the gas. When the liquid film controls, the driving force is $(c^* - c)$.

How to Derive Equation for Operating Line

The line in Fig. 1 which connects the three points is called an operating line. It shows the gas composition corresponding to the liquid composition at any given point in the absorber. The location of this line is fixed by a material balance.

The operating line is curved if we use partial pressure for gas composition and lb. moles/cu. ft. for liquid composition. We can derive the equation as follows:

The amount of solute in the gas entering at point 1 is $G'p_1/(\Pi - p_1)$ lb. moles. At point A, the solute in the gas is $G'p/(\Pi - p)$. Since G' is constant, the amount absorbed from the gas equals

$$G'\left[\frac{p_1}{\Pi - p_1} - \frac{p}{\Pi - p}\right] \text{ lb. moles} \qquad (1)$$

Similarly, for the liquid the solute at point A is $L'c/(\rho/M - c)$ and at point 1 where liquid is leaving equals $L'c_1/(\rho_1/M_1 - c_1)$. Since L' is constant and ρ/M may be assumed to be constant, the amount absorbed by the liquid is:

$$L'\left[\frac{c_1}{\frac{\rho}{M} - c_1} - \frac{c}{\frac{\rho}{M} - c}\right] \qquad (2)$$

Equating Eq. (1) and Eq. (2), we obtain an equation for the operating line:

$$G'\left[\frac{p_1}{\Pi - p_1} - \frac{p}{\Pi - p}\right] = L'\left[\frac{c_1}{\frac{\rho}{M} - c_1} - \frac{c}{\frac{\rho}{M} - c}\right] \qquad (3)$$

In design calculations, the values of G', L', c and p are usually specified. We can use Eq. (3) to calculate the points on the p-c curve. When concentrations are low $(\Pi - p)$ and $(\Pi - p_1)$ are each about equal to Π; and $(\rho/M - c)$ and $(\rho/M - c_1)$ to ρ/M. We find that Eq. (3) reduces to

$$\frac{G'}{\Pi}(p_1 - p) = \left(\frac{L'M}{\rho}\right)(c_1 - c) \qquad (4)$$

This equation gives a straight line with a slope equal to $L'\Pi M/G'\rho$.

Express Concentrations in Mole Fractions

Phase concentrations are often expressed in mole fractions. If we use this nomenclature, we have

G = Total moles of gas.
L = Total moles of liquid.
x = Solute in liquid phase, mole fraction.
y = Solute in gas phase, mole fraction.

The total moles L and G are not constant because they change as material is transferred from one phase to the other. For a differential height of absorber, we may write the differential equation

$$L\,dx = G\,dy \qquad (5)$$

Pressure Difference Measures Driving Force

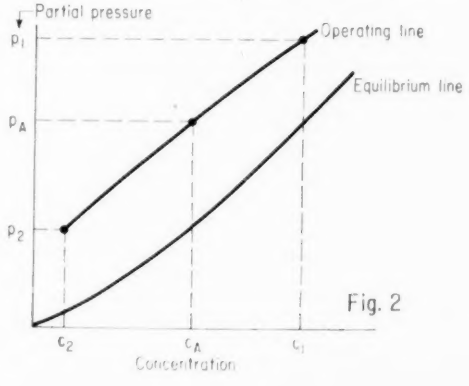


Fig. 2

For dilute concentrations where L and G are essentially constant, $dy/dx = L/G$ = constant. The x-y operating line is straight. When L and G vary,

$$(y_1 - y) = \int_x^{x_1} (L/G)\, dx \qquad (6)$$

Using solute-free gas and liquid flow rates, the operating line is:

$$G'\left[\frac{y_1}{1-y_1} - \frac{y}{1-y}\right] = L'\left[\frac{x_1}{1-x_1} - \frac{x}{1-x}\right] \qquad (7)$$

Mole Ratio Gives Straight Operating Lines

It is sometimes most convenient to convert all concentrations to mole ratio units. This procedure gives a straight operating line for the entire range of concentration. If X equals moles solute per mole of solute-free liquid and Y equals moles solute per mole of solute-free gas. Material balance is:

$$G'(Y_1 - Y) = L'(X_1 - X)$$

Solving this expression gives

$$Y = \frac{L'}{G'}(X - X_1) + Y_1 \qquad (8)$$

How to Derive The Rate Equation

Now that we have the equilibrium curve and the operating line, we can put them together on the same diagram as shown in Fig. 2. The difference between these curves is a measure of the driving force for mass transfer.

Using the rate equations given in the previous refresher (*Chem. Eng.*, May 19, 1958, p. 169) we can derive the equation for the total mass transfer in the absorber.

For the absorber shown in Fig. 3 with an area of 1 sq. ft., take a differential element of height dh at some level. The concentrations are constant for this interval and the rate equations are valid.

The following derivation is for over-all conditions based on gas pressures:

$$\text{Moles absorbed} = K_g a(dV)(p - p^*)$$

We can also calculate the number of moles absorbed by a material balance over the section:

$$\text{Moles entering} = G'\left[\frac{p + dp}{\Pi - (p + dp)}\right]$$

$$\text{Moles leaving} = G'p/(\Pi - p)$$

$$\text{Moles absorbed} = G'\left[\frac{p + dp - p}{\Pi - p}\right] = G'\left[\frac{dp}{\Pi - p}\right]$$

$$G'\left[\frac{dp}{\Pi - p}\right] = K_g a(p - p^*) \qquad (9)$$

The volume dV is the product of the cross sectional area and height. For 1 sq. ft. of area, dV=dh. Substituting this value in Eq. (9), we get

$$dh = \frac{G'\, dp}{K_g a(\Pi - p)(p - p^*)} \qquad (10)$$

On integrating Eq. (10), we get the height of the absorber. This can be done graphically. With the aid of some simplifying assumptions, an easier analytical solution is often possible.

Find Rate Equation for Gas Absorber

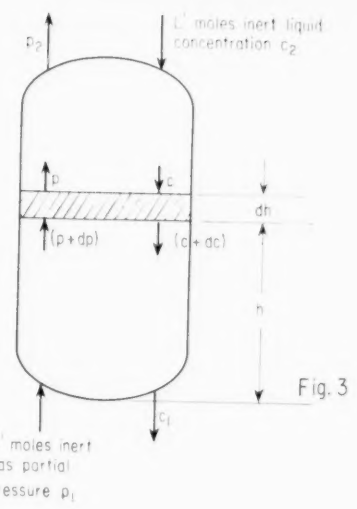


Fig. 3

Integrating the Mass Transfer Equation

One simplifying assumption is that $K_g a$ is constant. This rate coefficient depends on several factors, such as total gas velocity and the physical properties of the gas and liquid which may vary considerably within an absorber.

With this assumption, we can integrate Eq. (10) as

$$\int_0^h dh = \frac{G'}{K_g a}\int_{p_1}^{p_2} \frac{dp}{(\Pi - p)(p - p^*)} \qquad (11)$$

To solve Eq. (11), we first take an average value of $(\Pi - p)$. Then we have to find some relation between p and p^*. If we assume that the driving force $(p - p^*)$ changes in a linear manner, we obtain by a rather involved derivation the log-mean driving force expression.

$$h = \frac{G'(Y_2 - Y_1)}{K_g a\,(p - p^*)_{log\ mean}} \qquad (12)$$

In Eq. (12), we define the log-mean driving force as:

$$(p - p^*)_{log\ mean} = \frac{(p - p^*)_2 - (p - p^*)_1}{\ln_e \dfrac{(p - p^*)_2}{(p - p^*)_1}} \qquad (13)$$

The literature on absorption and extraction contains a bewildering variety of equations such as Eqs. (10) and (12). The variety results from the use of different kinds of concentration units at one place or another. Basically, these equations are quite similar. Using any of them is just a problem in keeping the units straight.

Problem Illustrates Use of Equations

The following problem illustrates analytical and graphical methods of solving mass transfer problems.

Problem—Find the height of an absorber for absorption of benzene from air into an oil given

$G' = 30$ lb. moles of air/sq. ft.-hr. and $\Pi = 2$ atm. and $\rho/M = 0.2$ lb. moles/cu. ft. Also when $x_1 = 0.05$ mole fraction, $y_1 = 0.20$, and when $x_2 = 0$, $y_2 = 0.01$.

Under these conditions, the equilibrium curve is $p = 1.25c$ where p = atm. and c = lb. moles/cu. ft. Also assume mass transfer coefficient is constant throughout absorber and $K_g a = 2$ lb. moles/hr.-cu. ft.-atm.

Analytical solution—The operating and equilibrium lines are plotted in Fig. 4. Since the operating line has some curvature, the driving force Δp isn't quite linear. However, it isn't far off, so we can use Eqs. (12) and (13) for a good approximation.

When $c_1 = 0$, $p_1^* = 0$ and $p_1 = 0.02$ atm. Therefore, $(p - p^*)_1 = 0.02$. When $c_2 = 0.25$, $p_2^* = (1.25)(0.25) = 0.312$ and $p_2 = 0.400$. Therefore $(p - p^*)_2 = 0.088$.

We can now calculate the log mean pressure difference and find that it equals 0.0459. Also $Y_1 = 0.01/0.99 = 0.01$ and $Y_2 = 0.20/0.80 = 0.25$. Substituting the various quantities in Eq. (12), we find the height h equals 80.2 ft.

Graphical solution—Values of p and p^* are taken from Fig. 4. Using these values, we make the calculations shown in the table under Fig. 5. The function $1/(\Pi - p)(p - p^*)$ is plotted in Fig. 5. The area under the curve from $p = 0.01$ to $p = 0.40$ is found by the methods described in *Chem. Eng.*, Dec. 1957, p. 282.

$$h = \frac{G'}{K_g a} \int_{p_1}^{p} \frac{dp}{(\Pi - p)(p - p^*)}$$

$$= \left(\frac{30}{2.0}\right)(4.544) = 68.2 \text{ ft.}$$

This answer is lower than the one obtained by using log mean driving force. The true driving force in the middle of the absorber is greater than that assumed for a straight operating line.

Other Uses of Mass Transfer Coefficients

We've discussed only gas absorption thus far as being typical of mass transfer operations. For other mass transfer operations a similar treatment gives useful design equations. There are variations depending on the mode of operation.

Use Partial Pressures for Mass Transfer Eq.

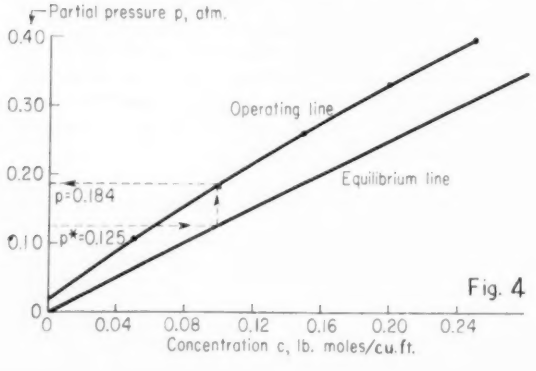


Fig. 4

Graphical Integration of Mass Transfer Eq.

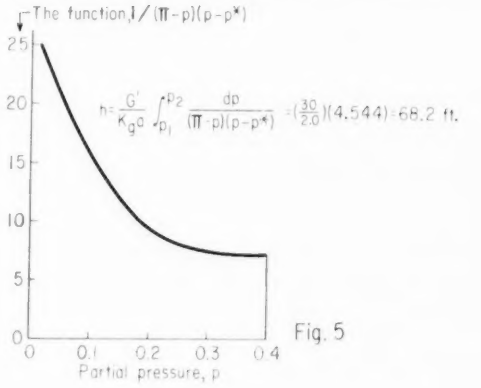


Fig. 5

p	p*	(p − p*)	(Π − p)	$\frac{1}{(\Pi - p)(p - p^*)}$
0.020	0	0.020	1.980	25.2
0.105	0.072	0.033	1.895	16.0
0.184	0.125	0.059	1.716	9.89
0.262	0.187	0.075	1.738	7.68
0.333	0.250	0.083	1.667	7.23
0.400	0.312	0.088	1.600	7.10

Liquid extraction is often carried out as a counter-current operation with tranfer of solute from one moving liquid phase to another which flows in the opposite direction. In dilute solutions an equation similar to Eq. (12) applies:

$$V = \frac{N}{K_{ga}\, \Delta c_{log\ mean}} \qquad (14)$$

Here, V is the volume of the extractor, N the moles of solute extracted and $\Delta c_{log\ mean}$ is the log mean concentration driving force.

Gas humidification is a special case of gas absorption, in which solute moves into the gas stream and the liquid-film resistance is zero. Operation is usually parallel-current with a high driving force at one end, and a very low one at the other. The equations previously derived for gas absorption apply in this case.

Crystallization and dissolving take place with a constant concentration at the interface. If a batch process is used, the solution phase concentration changes. An equation for total time can be derived and required equipment size calculated. In a continuous process, the concentration varies with the position in the equipment. However, a complication arises because the area changes as the crystal grows or dissolves.

Looking Ahead

Next month, we start a new series on mass transfer in which we take up theoretical contacts, equilibrium stages and transfer units.

In many situations, these concepts are proving superior to the older mass transfer coefficient treatment.

CE Cost File—I

By Harold Gushin,
General Aniline & Film Corp., Linden, N. J.

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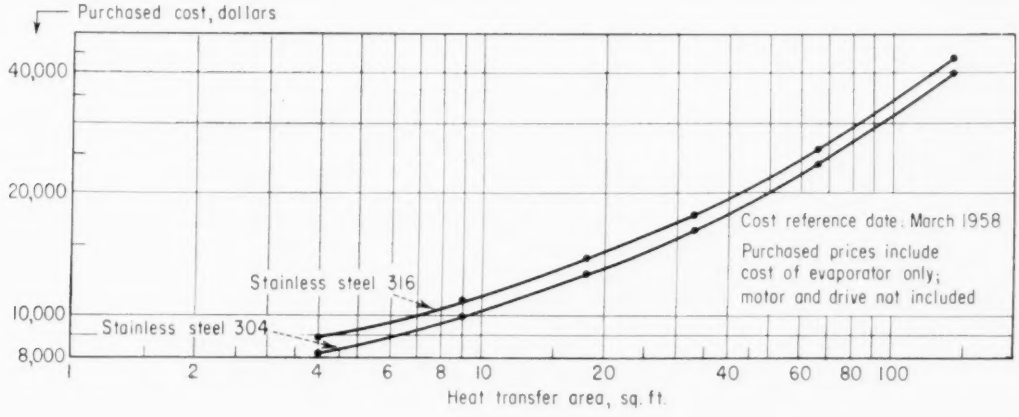
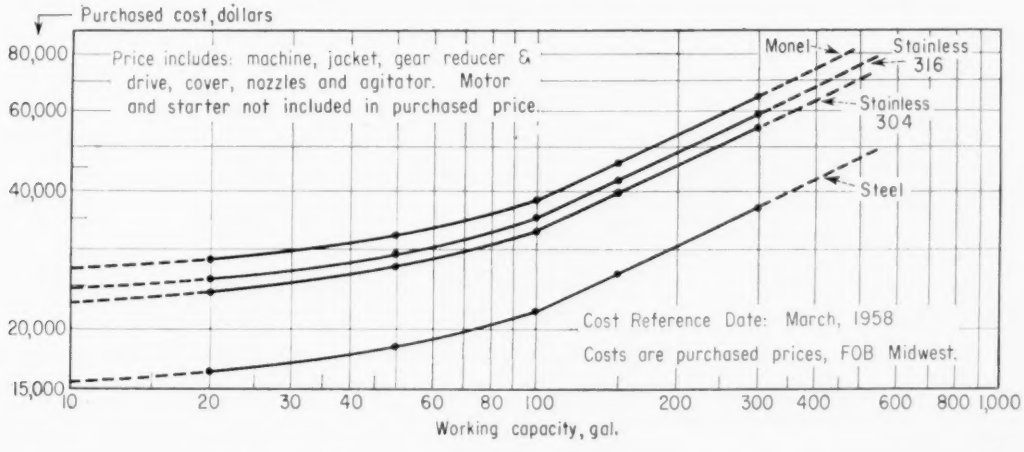
▶ **Send your cost data,** preferably in tabular or graphical form and with a minimum of text, to CE Cost File Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. Any legible form is acceptable. We will pay regular space rates for all published material.

▶ **Next:** Handy Cost Charts for Tanks and Kettles.

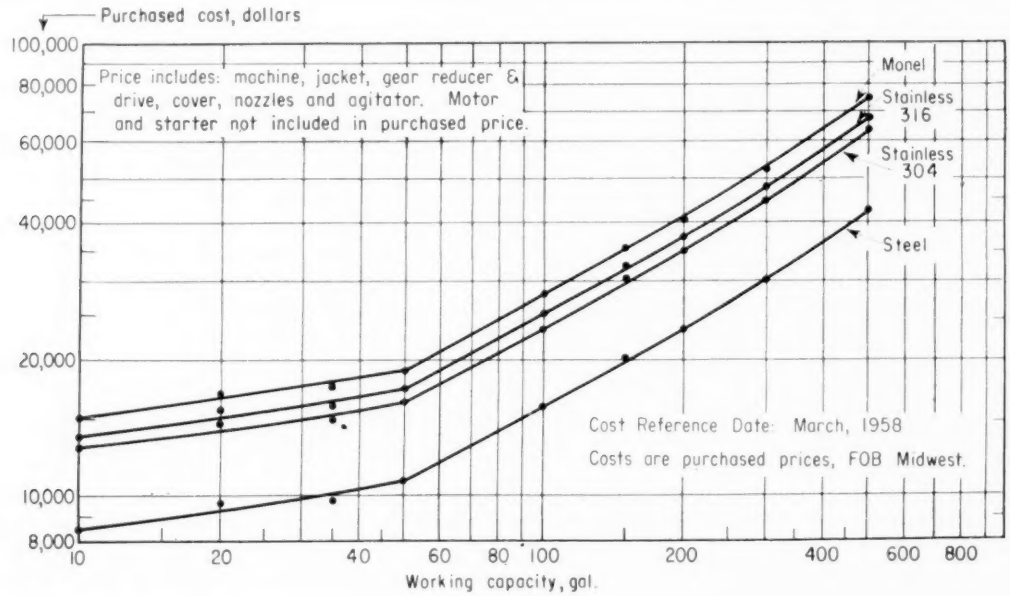
Agitated Falling-Film Evaporators



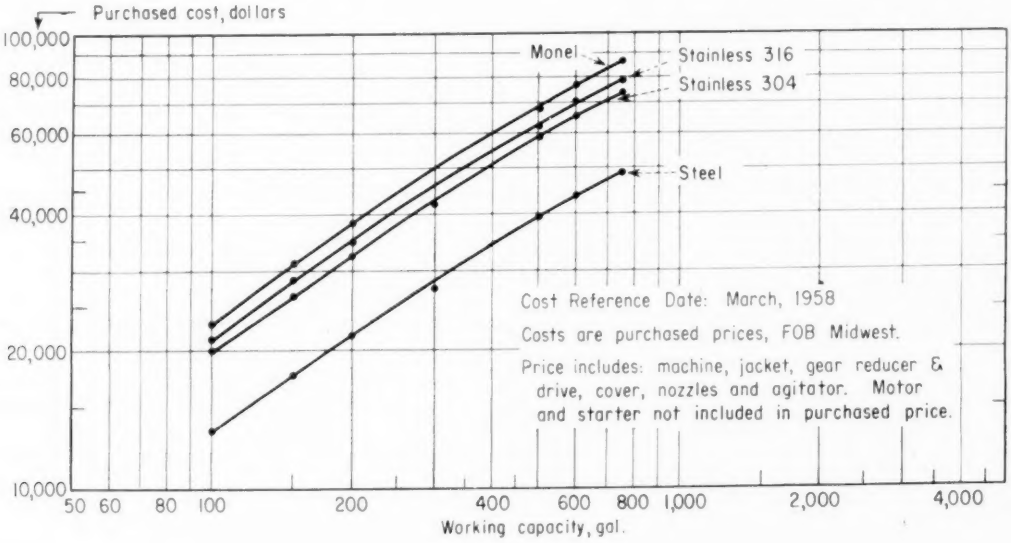
Vacuum, Tilting-Type Double-Arm Kneaders



Tilting Double-Arm Kneaders



Stationary, Upright Double-Arm Kneaders



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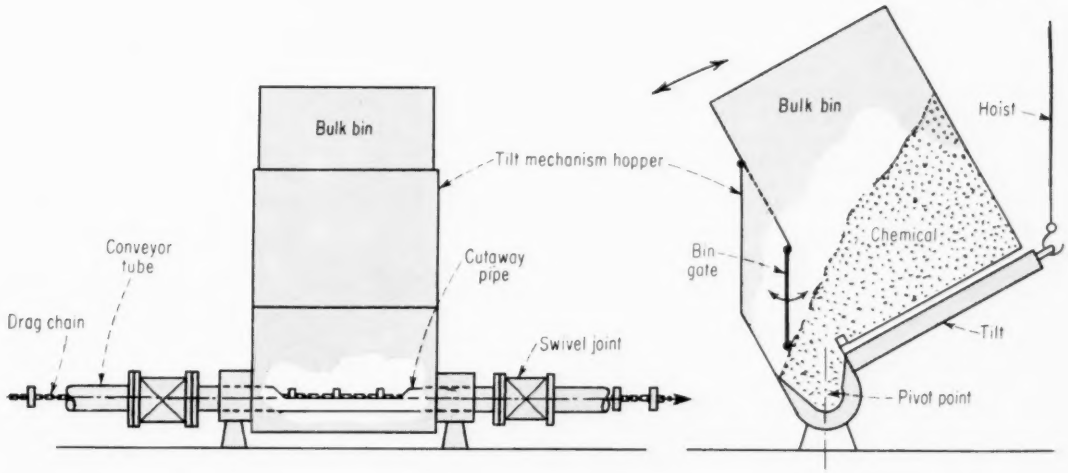


Build a Dust- and Water-Tight Unloader

A semi-hazardous granular chemical handled in bulk bins is unloaded safely by making the unloader part of the conveyor.

★Winner of the April Contest by Oliver D. Dressel
Chemical Engineer, Technical Services Dept., Organic Chemicals Div., Monsanto Chemical Co., St. Louis, Mo.

A couple of years ago we were faced with the problem of engineering a bulk handling system for a semi-hazardous granular chemical for which it was important that the system be both dust-tight and water-tight.

Our decision was to receive the material in sealed bulk bins (Tote Bins) and then to unload it direct to a tubular drag-chain (Hapman) conveyor which would carry the material from the bins to the process vessel. In this way the material would be totally enclosed during both shipment and conveying. However, neither the conveyor nor the bin manufacturer had previously built a completely water-tight system for transferring such material from the bins to a conveyor.

At first it seemed that the design of a water-tight connection between the conveyor and the bin maker's unloading tilt mechanism would be unusually difficult. In this system the bins are handled by fork truck and for unloading are placed on a tilting arm secured to a hopper against which the bin rests. When the arm is lifted the bin and discharge hopper pivot to a 45° tilt, the bin gate opens and the material discharges.

It was clear that the water-tight connection would have to

NEXT ISSUE: Prevent Plugging of Gages and Recorders

By L. E. McLane, Winner of the May Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

pivot on the axis of the tilt mechanism. We conceived numerous ideas employing close-fitting sliding parts or flexible bellows-type arrangements but none seemed to have the possibilities of the idea finally adopted.

The ideal solution, shown on the sketch, consisted in making the bin tilt mechanism a part of the conveyor itself. We had the tilt manufacturer modify the tilt by installing a segmental portion of steel pipe the same size as the conveyor. This was concentric with and ran through the tilt trunnions. It was cut and installed to allow the chemical to flow into the pipe. We connected the latter to the tubular conveyor at each end by means of a Chiksan swivel joint. We then threaded the drag chain directly through the tilt mechanism. The result was completely dust- and water-tight and in over a year has given essentially trouble-free service.

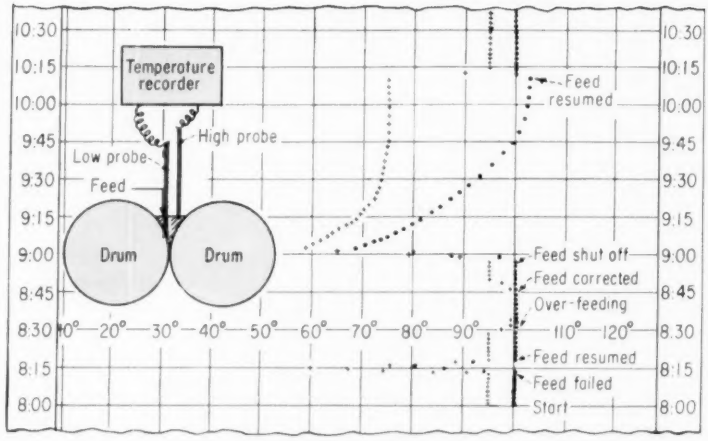
Safety Interlock for a Splashing Mixer

Buckley Sullivan
Engineer, Cleveland, Ohio.

We have a small homemade mixer which we use for mixing caustic solutions. It mixes perfectly but does have a tendency to splash and slop when the paddles in the mixer vessel strike the surface of the solution or air bubbles burst at the surface.

On this account we built a small room around the mixer to protect the personnel who work nearby. As a further precaution we mounted the switch for the mixer motor outside the room and beside the door. Unfortunately, one of the men forgot to shut the door as he threw the switch and received a nasty caustic burn on the hand from a freak splash.

To prevent any recurrence we took one more step—installing a limit switch on the door jam, interlocked with the motor circuit. Thus, the circuit is open regardless of the switch unless the door is shut. Furthermore, opening the door while the mixer is operating will shut down the motor.



Controlling Feed Level in a Drum Dryer

Martin Kladko
Chemical Engineer, General Aniline & Film Corp., Rensselaer, N. Y.

Our plant had the problem of increasing production from five double-drum dryers which were used on a variety of feeds ranging from slurries, gravity fed from an overhead kettle, to hard pastes shoveled into the dryer by hand. The solution seemed to lie in obtaining a uniform feed and preventing periods when the dryers would run empty due to operator inattention.

Several ideas were tried to warn the operator when a dryer was empty. Neither the use of conductivity probes nor capacitance-type probes in the material between the drums gave satisfactory results due to fouling, poor contact and the need for separate calibration for each product handled.

At this point the Process Engineering section was called in. We developed the idea of using temperature variations at different levels between the drums as a measure of level. We installed two thermocouple probes as in the sketch, one close to the "bite" of the drums and the other with its lower end at the highest allowable feed level. This last location was critical since overfeeding would leave the product in contact with the hot drum surfaces too long and reduce product quality.

The temperature record shows how this scheme worked out. Temperature of the lower probe (small dots) would always stay at 100-103 C. so long as there was some feed between the drums. If the drums went dry the lower probe temperature would first drop to about 70 C., then slowly rise and level off close to 105 C. With the upper probe, temperature would be about 95 C. (small x's) when feed was at the proper level. With too high a level it would reach the same temperature as the lower probe. But if the rolls went dry the high probe temperature would level off at 75 C.

The record above is that of a typical run. Starting the feed at 8:00 o'clock, level was maintained properly until 8:14 when the feed was interrupted. Both temperatures dropped. Feeding was resumed at 8:16 and continued properly until 8:29 when over-feeding occurred. At 8:50 the feed was corrected and the temperatures became normal. Then, at 8:58 feed was discontinued and the dryer ran empty until 10:10 when feeding was resumed.

This arrangement was unaffected by fouling and handled a wide variety of feed consistencies without trouble. It could easily actuate warning devices or automatic feed control.

Watch for these warning signs:

- **Is your timing off?**
- **Do you overlook details?**
- **Are you always overworked?**

Mental Fatigue Can Sabotage Your Success

P. W. Eatman, The Fluor Corporation, Ltd., Houston, Tex.*

"To be awake is to be alive," Thoreau said. But our intervals of being fully awake and delicately tuned to life are few and memorable.

On those "special" days, our souls feel close to communion with the infinite. Our minds become precision machines. We are capable of anything. And one of the greater pleasures is the satisfaction of getting a week's work done in a few hours.

We have set an example for ourselves in using time efficiently. Our associates are impressed and inspired. We are self-confident, happy, civil of tongue and considerate of others. We are on top of the world. If we could just perpetuate this ethereal state of being, we would be Chairman of the Board in no time at all.

Just how *can* we keep it up? And, as we become responsible for the work of others, how can we get them to perform at maximum efficiency?

To phrase it in the language of process engineering, we have to "keep the recycle down and the production up." Of course, the user must know the difference between recycle and product before he can apply the rule successfully.

In the vernacular of physics, "work is equal to force times distance." Our own physical or mental work requires force and distance. It takes both. We can use all sorts of force and get no work done. Sometimes we "outdistance" the job, suddenly finding ourselves at some unfortunate point farther removed from the correct solution than the point at which we started.

"All right, I understand this analogy," you say, "but just how does this recycle build up and what can be done about it?"

The answer to the first part of this question is illustrated by peeking into the private life of a typical recycle builder, whom we will call Mr. P.D.Q.

Introducing Mr. P.D.Q.

This man is a real ball of fire. When a rush job comes along, he shifts into high gear. Just a sandwich for lunch and a quick hamburger at the local hash house for dinner. Then back to the office for night work.

And this schedule is not a one- or two-night deal. Old P.D.Q. is too ambitious for that. He goes back night after night after night. The other boys drop out gradually, until he is all alone. P.D. admits to himself that these other fellows are not quite up to snuff. If the company is going to succeed, he will have to take up the slack.

So he takes on more and more work. Pretty soon he is coming to the office at nine instead of the customary eight in the morning. No one objects. Everybody understands how hard he is working. P.D. grinds his way through reams of calculations before he discovers that some of the data he is using doesn't fit. To make matters worse, word comes through to change the design basis. This means the whole thing has to be done over.

He just cusses and swears and works harder. Finally the job is complete and the chickens come home to roost. The operating superintendent is mad at the chief

* Meet your author on p. 206.

engineer, the chief draftsman is suffering from acute indigestion and the purchasing agent is fit to be tied.

All the Credit Goes to Our Boy

But P.D. has done the work single-handed. You have to give him credit for that. Of course, nobody fully appreciates his supreme effort and sacrifice. They all feel bypassed and left out, and there are some who even insinuate that the finished job is not the best in the world.

This is hard for P.D. to take. He wonders how the so and so's expect to force the entire burden on one man and not have a few minor errors creep into the job. Yes, P.D. is a real "company man," and you just can't help admiring him a little for the tremendous effort he puts out. But somewhere something has gone radically wrong.

It would be nice if all of the preceding were fiction. However, we know that almost every engineering group has occasion to observe some similar situation.

We ought to analyze what is wrong with P.D.Q. Could he be a victim of mental fatigue? Is all of his "churning" around a predictable thing? What symptoms does he exhibit that we may compare with other scientifically determined information, so that we may properly diagnose his case?

Mental Fatigue Is Nothing New

This "mental fatigue" problem is nothing new. A very interesting series of experiments was carried out in Britain during World War II to study effects of central nervous system fatigue.

Aircraft pilots were the subjects and, since the tests were made during wartime, many specific details were not published for security reasons. However, the general nature of the work and those results that have been published afford an excellent insight to the problem.

Aircraft pilots exercise a very high degree of skill and intelligence in reading and interpreting a maze of instruments. Translation of these stimuli into correct positive action is required to assure continuation of safe operation.

Very Similar to Engineering

Comparing problems of pilots with those of engineers shows a great similarity. Both groups are required to perform a variety of routine tasks under continuous pressure.

Occasionally, and at times very unexpectedly, some change forces a completely new approach to the problem. It's not unusual for this change to require a re-evaluation of work already completed. Pilot and engineer are often beset with serious distractions right in the middle of efforts to continue normal routine planning.

The British tests synthesized these problems. They investigated the effect of continuous work to the point of extreme central nervous system fatigue.

Recognize the Symptoms

Here's what the symptoms of fatigue are reported to be:

- As fatigue increases, the subject becomes more and more indifferent to an increase in deviation from an established control point. Standards of action drop considerably.
- Timing grows worse. Corrective action shows a large increase in right action performed at the wrong time.
- Ability to interpret the instrument panel as a whole gradually gives way to mentally splitting up the panel into separate instruments. Corrective action becomes increasingly sensitive to individual instruments. Quality of control decreases. The effects of temperament become noticeable.
- Merely occasional stimuli break away and tend to be forgotten.
- Operators' reports of what is happening become less reliable.
- Mistakes are increasingly believed to be due to the machine, or to the experimenter.
- Awareness of physical discomfort increases enormously, and its interpretation becomes less accurate.
- Irritability increases.
- Control handling grows rougher; actual physical work increases.

The Best Single Measure

In this British study the best single measure of fatigue was the widening gap in the effective range of the subject's work. In other words, as mental fatigue increased his work became less accurate. Timing was very important as a qualitative sign of fatigue. Judgment of the amount of time elapsed became quite erroneous.

Knowing about these telltale signs of fatigue can be very valuable in setting our own work pace. We should watch for these symptoms in ourselves and in those under our supervision. If these signs are not heeded, the recycle rate is sure to go up and the production rate down. The finished product will show signs of sloppiness. We will become discouraged with ourselves, the company and the job.

Eliminate the Causes

When we recognize the symptoms, we must proceed to eliminate the causes. Simple physical fatigue could be one. Adequate rest and proper diet should be a solution. Some people sweat over their problems 24 hours a day. This can set up a vicious cycle.

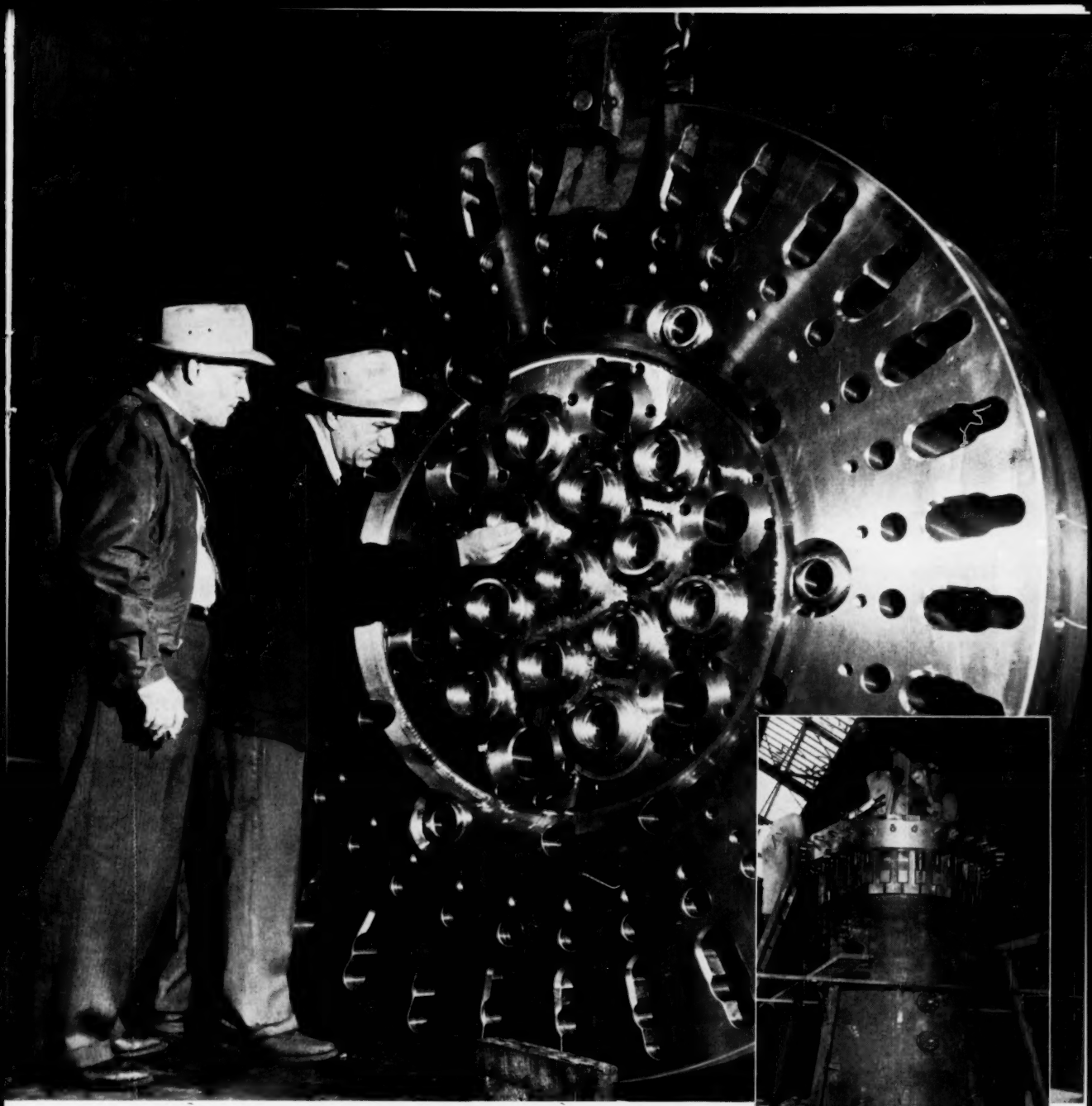
Of course personal and family problems may be at the root of the trouble. Solutions to these problems may be complicated enough to require the services of your family physician or of certain medical or social-science specialists.

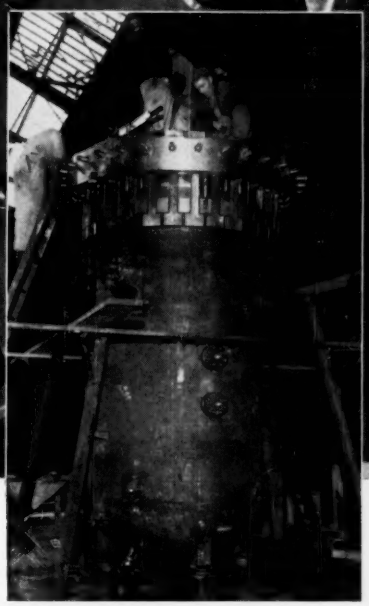
One of the most prominent causes of mental fatigue is interruption of work. Nothing is more frustrating than being continually forced to stop in the middle of a job and to start out on some new basis. Many such distractions can be eliminated by proper planning at the supervisory level.

We engineers are "efficiency" conscious. Our plants and processes are designed for maximum return on investment. But what about "personal" efficiency? By operating at maximum personal efficiency—by acquiring a better understanding of mental fatigue—we should achieve more rewarding success.

REFERENCE

Bartlett, F. C., "Fatigue Following Highly Skilled Work," *Proc. Royal Soc.*, **B 131**, pp. 247-257 (1943).





This pressure vessel had to be designed with a closure that would open in 30 minutes, and withstand 1500 psi, 550F. Made of Type 304 stainless, the top head has 34 connections, of which 19 required exceptionally close tolerances for control rods.

FOR NUCLEAR NEEDS of Knolls Atomic Power Laboratory, M. W. Kellogg was given the exacting assignment of designing and producing a 32½-ton "Proof Test Reactor Pressure Vessel". This was an unusually complex task, because of the quick-opening closure specifications, requiring a head with novel design and extremely close tolerance machining.

FOR NUCLEAR NEEDS of others, Kellogg is supplying the primary coolant stainless piping for two nuclear plants. In addition, Kellogg is equipped to engineer and manufacture heat exchanger equipment for nuclear energy power plants. If these specialized skills suggest a solution to *your* nuclear problems, call Kellogg's Fabricated Products Sales Division.

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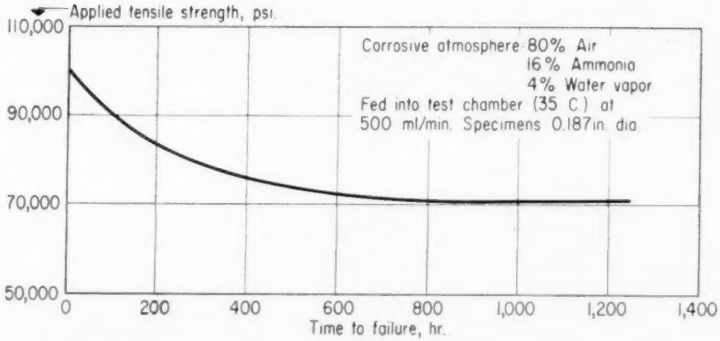
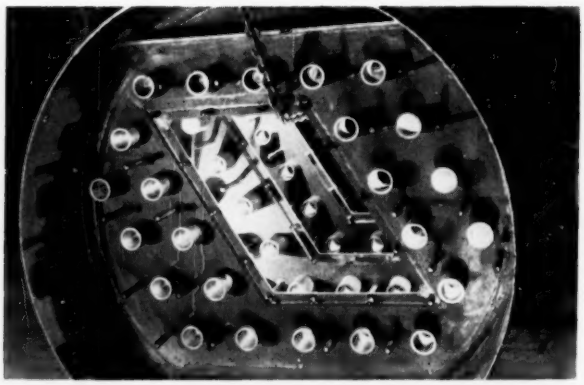
M KELLOGG W

1 **Nickel is vital ingredient in novel silicon bronze. It prevents corrosion cracking.**





2 **Unique aluminum bronze contains tin or silver to prevent Al segregation; stands up to chemicals under heat and pressure.**

Two New Copper Alloys Down Stress Corrosion

Performance tests on two new wrought copper alloys strongly indicate that they both have solved a long standing problem: stress corrosion cracking.

Chase Brass and Copper has developed a brand new silicon-copper alloy, containing nickel, which is dubbed Silnic bronze (*see above*).

Long plagued by unexpected equipment failures, Ampco Metal has come up with a modification (*see above*) of their popular aluminum-copper-iron alloy, Ampco 8.

▶ **Weak Points**—Alloying elements are added to copper for a number of reasons. In the silicon bronzes, silicon increases the strength and hardness of copper. There are two types on the market, one has 1.5% Si, the other 3% Si. But silicon has one major failing. It tends to segregate during the melting operation. This is particularly true in the 3% silicon composition, but still serious in the lower silicon alloy.

The segregated silicon areas are weak points, subject to chemical attack, particularly when a section is under stress.

▶ **New Si-Bronze** — Chase's approach to this serious problem was to lower the silicon concentration. The new alloy has 0.45-0.75% silicon, but a high nickel content — 1.60-2.20%. Tensile strengths are in the order of 100,000 psi. for hard temper material, compared to about 92,000 for 3% silicon bronze.

Nickel is a vital ingredient here. It ties up the silicon as silicides, preventing corrosive attack.*

One other factor contributes to Silinic's resistance to stress corrosion: it can be age hardened by a simple heat treatment (850 F. for 90 min.), which boosts its strength. The older silicon bronzes have to be cold worked to boost hardness and strength. This treatment builds up uneven stress distributions,

* The major improvement is in stress corrosion resistance. General corrosion resistance is about the same as standard silicon bronzes. However, electrical conductivity is 5 times the usual silicon bronzes.

A NEW
DURCO TYPE F VALVE

now available

In the 4" size

Previously Available ¼ ½ 1 1½ 2 3 now 4"

The 4" Durco Type F valve with renewable Teflon sleeve is now available from stock in Durimet 20 and Durco 18-8-S-Mo. This non-sticking, non-lubricated heavy duty chemical service valve is also available on special order in a wide variety of alloys including Chlorimet 2, Chlorimet 3, Monel, Nickel, and Inconel. Call or write

THE DURIRON COMPANY, INC. / Dayton, Ohio

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, and Pittsburgh

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

while age hardening results in an uniform stress cross-section.

Lab tests have pointed up these claims. A typical test (*results shown p.* 194) involves threading a 0.187-in. dia. rod at both ends, then placing the rod in a coil spring. Nuts are screwed on the threads, building up a tensile load.

Available now in rods and wire, it is still under development for tubes and sheets. Cost is equal to 3% silicon bronze.

Work is also going on in welding of the new bronze, since there is some loss of stress corrosion properties in the welded area (as in all age-hardened metals).

New Al-Bronze—In the aluminum bronzes, aluminum is added more for corrosion resistance than for strength improvement. But Ampco Metal was faced with a similar problem, the segregation of aluminum during the manufacture of their aluminum-copper-iron alloy.

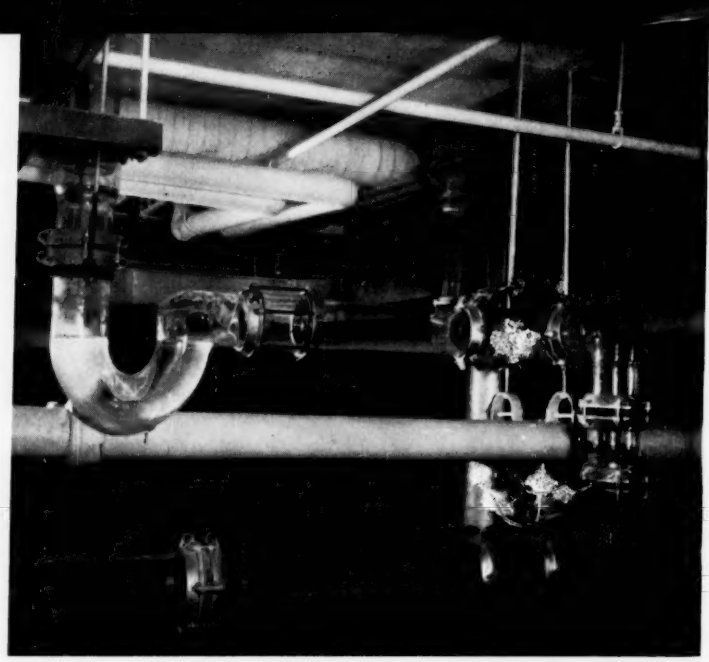
A corrosive attacks and oxidizes the aluminum areas, high stresses break the oxide film and this goes on to failure.

▶**Real Villian**—Steam containing acids, alkalies and salt solutions has given the most trouble in pressure vessels fabricated out of the old Ampco 8. This occured even after the vessel was stress relieved.

Ampco was anxious not to change the basic 91Cu-7Al-2Fe composition. But all sorts of complex processing variations during metal production did little in solving the problem.

Actually the final solution is very simple: addition of 0.35% tin or silver. What results is a "tailored made" alloy, with all the corrosion resistance, fabricating, physical and mechanical properties of the older alloy, except it has far superior resistance to stress corrosion.

There is no doubt the additive works, although Ampco is not sure how. Field tests on new Ampco 8 (crystallizers, piping, driers) and numerous lab tests bear out Ampco's claims. There has been no field test failures. One other advantage comes out of this development: there is no need to stress relieve a fabricated part to increase corrosion resistance.



Glass Drainlines Catch On

New entry in severely corrosive drainline service: transparent, easy-to-maintain glass.

Glass (borosilicate) piping is making a strong bid for a part of the chemical drainline market.

Competing against such established materials as high-silicon iron, black iron, porcelain, Corning claims transparency is a big advantage—plugged lines and filled traps can be spotted and cleaned easily.

And only hydrofluoric acid, phosphoric acid with traces of fluoride, and hot alkalis measurably affect a glass pipeline.

The glass has smooth, hard surfaces. Actually sludge has little chance of choking the piping; solids don't cling and cleaning is relatively easy.

▶**Heavy Wall Tubing** — The glass pipe and fittings are made from heavy walled tubing of borosilicate glass, machine drawn to insure uniformity. End flanges are accurately machined and pressed flat. Ends of all straight lengths for about 6 in., and all standard fittings, except caps, traps, and U-bends, are heat treated for extra strength. The glass pipe comes in sizes from 1 to 6-in. I.D.

A complete line of pipe fittings is available, including elbows of various angles, tees, Y-branches, crosses, traps, cup sinks, spacers and adjustable joints.

▶**Flanged Joints** — Joints are made with standard flanges drawn together by bolts using interface gaskets of rubber, asbestos, Teflon, neoprene, Koroseal, or other material depending upon the fluid intended to be carried through the line.

The conical flanged joint for glass pipe is designed with consideration of the mechanical properties of glass—high compressive strength, but limited tensile strength.

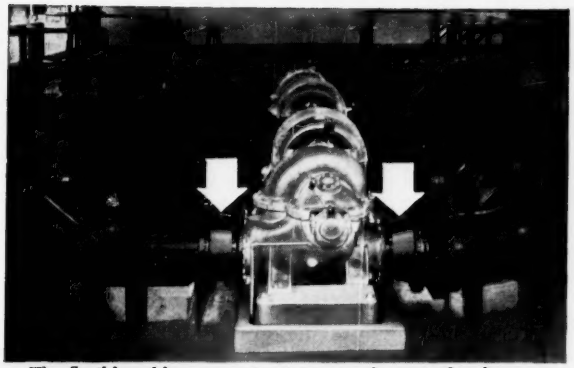
Traps are either of the P or cap type with removable cap.

A 10-ft. length of 2 in. pipe weighs 11.3 lb., compared with 37 lb. for a similar length of 2 in. steel. Joints can be made with two small wrenches. There is no need for hot lead in tight places.

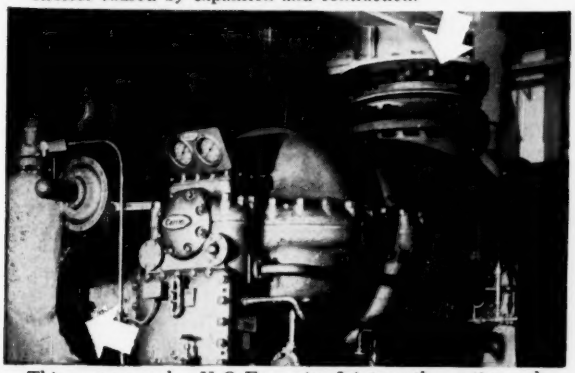
Glass piping connects with pipe of other materials; partial installations tying in with other lines have been successful. This provides the advantage of "installation as needed" when replacing parts of systems on a piece-meal schedule.

EXPANSION JOINTS

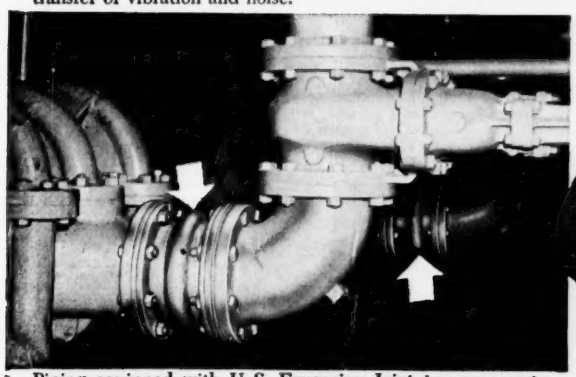
Expanding the Designer's Scope



The flexible rubber expansion joints on the centrifugal pump installations (above) are made by U. S. Rubber. They prevent stresses caused by expansion and contraction.



This compressor has U. S. Expansion Joints on the suction and discharge lines. Like all U. S. Joints, these insulate against the transfer of vibration and noise.



Piping equipped with U. S. Expansion Joint to compensate for any misalignment caused by load stresses, wearing of parts or settling of building.

U. S. Rubber Expansion Joints are resilient and therefore do not, like metal, set permanently when compressed. Constant flexing merely keeps them alive... prevents brittleness.

- They absorb both axial and lateral deflection far more than metal joints. Greater insulation against vibration and pump noises. No electrolysis, corrosion or erosion.
- Handle pressures from 40 lbs. to 125 lbs.
- The outside diameter of the arch is smaller than on metal joints. (Face-to-face dimensions, even with multiple arches, are smaller.)
- Weight is much less. This, plus the fact that no gasket is needed between flanges (metal joints require gaskets) results in an easier installation lowering the cost.

"U. S." was the *first* to develop expansion joints. They are at work in every kind of industry, prolonging the life of equipment in pressure or vacuum pipe systems. Some are still in service, after 30 years of operation. Obtainable at any of the 28 "U. S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

For the complete technical information catalogue on the entire line of U. S. Rubber Expansion Joints, contact your nearest "U.S." District Sales Office or write us at Rockefeller Center, New York 20, New York.

Mechanical Goods Division

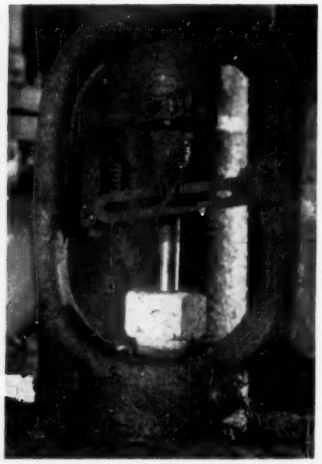
United States Rubber

▶**Good Cost Picture**—Based on first cost, installation cost and maintenance cost, financial outlay for glass drainlines has been competitive with other materials. Several factors enter into this situation:

• Installation. Light weight means quick, easy installations. Longer lengths of piping result in fewer joints. The joints eliminate the need for packing usually found on other drainline installations.

• Maintenance. Replacement costs due to breakage and leakage at the joint are all but eliminated. The anti-corrosive qualities of the glass cancel out the major replacement expense of other materials. With positive compression joints, the seal is permanent. There's no pocket for corrosive wastes to gather. Both pipe and gasket are corrosive resistant.

Corning looks to some widespread applications for glass drainlines. They point to a recent cement factory application as a sign of future developments: acids thrown down the drain to break up cement deposits were wiping out sink traps. A new glass installation is withstanding this situation. So far maintenance has been extremely low.



Zirconium Outlasts Stainless in Chlorine Service

Zirconium components in highly corrosive liquid chlorine process service are outlasting stainless steel parts by 4 to 20 times.

Columbia-Southern Chemical —a part owner of zirconium-producing Columbia-National Corp. —has now standardized on zirconium for automatic control valve components in liquid and gaseous chlorine service, at their Naturium, W. Va., plant.

A typical valve uses a zirconium stem with Teflon chevron packing (*above, right*). Older valves were equipped with Type 316 stainless steel stems, which lasted from one to six months (*above, left*).

In addition to the stems, Columbia-Southern engineers have redesigned the assembly to incorporate a flanged zirconium packing gland in place of the stainless packing nut. Corrosion of the stainless nut threads were severe, making it difficult to tighten or remove the nuts. Zirconium also will be used for the packing gland hold-down studs and nuts.

Titanium Welding Not Difficult

A new 32-page booklet, which recently crossed our desk, may prove of value to anyone interested in or now working with titanium.

It's offered by Titanium Metals Corp. of America (N.Y.C.) and called "Titanium Welding Techniques." Well illustrated, it contains useful information on how and where to weld titanium.

We tend to agree with the main thesis of the booklet: it's not impossible to weld (fusion or spot) titanium, but precautions and techniques are very critical for a satisfactory weld.

Argon or helium shielding, of course, is a must. Titanium is subject to severe embrittlement by relatively small amounts of impurities (oxygen and nitrogen). Because of this there is an important difference between inert-gas shielded arc-welding of titanium and normal practice. The root of the titanium weld, as well as the well face, must be protected from air.

Tungsten arc (nonconsumable) welding is the most widely used for titanium. It's mainly for thicknesses up to 0.125 in.

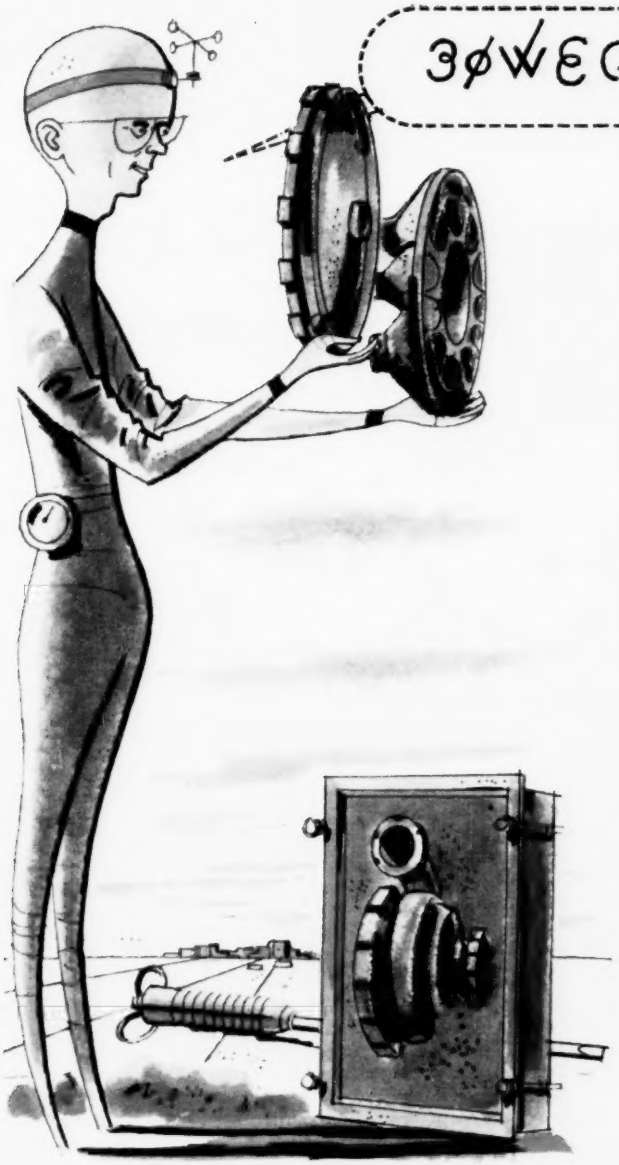
Metal arc electrodes (consumable) are recommended for heavier gages, although it has been used for butt-welded joints on 0.125-in material, and for fillet joints on 0.060-in. gage.

Much of the early welding on titanium was carried out in enclosed chambers under a blanket of inert gas. Newer developments allow welding outside a shielded chamber, but small parts and complex shapes are still welded more easily inside an enclosure.

One type of chamber consists of a transparent plastic dome, with various sets of entry ports which permit accessibility to all the joints to be welded.

Open air welding depends on inert-gas shielding with a combination of trailing shields and inert back-up shields. The weld puddle and adjacent heat-effected areas are protected by the nozzle or main shielding gas.

In most cases the purity of welding grades of argon and helium are satisfactory for Ti.



*Which translated from the language of 5796 A.D. means

"I judge that in 1958 A.D. Waukesha Foundry cast all 3"

Our archeologist of 5796 A.D. is right. Waukesha *does* cast metals in 3 classifications:

- Stainless Steel, 300-400 series, Ni-resist and special corrosion resistant formulations
- "Waukesha Metals" (copper base high nickel alloys), pure nickel, Monel, brass, bronze, Everdur
- Aluminum — as cast and heat-treated

Specialists and pioneers in corrosion-resistant alloys, our research laboratories have developed WAUKESHA METALS 23 and 88 which have excellent non-galling characteristics combined with high corrosion-resistance. Both these metals are homogenous in texture; both cast without hard or soft spots and machine freely.

In any of the 3 classifications of metals, nominate WAUKESHA Foundry as your source. Or if you have casting troubles or problems — write us about the conditions which must be met. Our Research Laboratories are here to provide the answers.

Waukesha
FOUNDRY COMPANY
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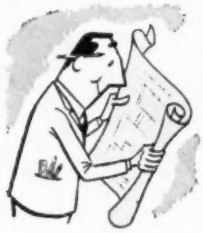
WAUKESHA has 3 separate foundries specializing in 3 classifications of metals. Two foundries at Waukesha, Wis. and one at Watertown, Wis.

Using Salt Efficiently

by INTERNATIONAL SALT COMPANY, INC.



Making Automatic Salt Dissolvers from Existing Plant Equipment

A great many industrial companies and public institutions are now enjoying the benefits of pure, fully saturated rock-salt brine at remarkably little cost. They have found that expensive new equipment is not needed to make this brine! Instead, International has shown them how to convert unused or unproductive plant equipment into salt dissolvers that operate under the Lixate Brine-Making Process.

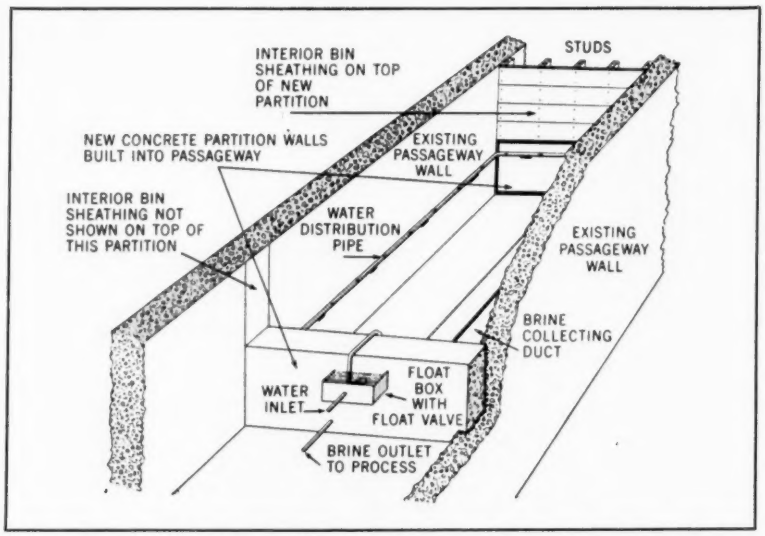
Here are four typical examples from the scores of special salt dissolvers that have been made from unused storage rooms, coal silos, locomotive tenders, dry salt bins, etc. These dissolvers, in addition to saving space, did not require expensive materials for their "construction."

Steel gas tank. Here, an unused circular steel tank under a sidewalk was converted into an underground Storage Lixator. (The Lixator is a rock-salt dissolver developed exclusively by International Salt Company.) This unusual Lixator is fully automatic, needs very little maintenance. Salt delivery is no problem at all: trucks dump Sterling Rock Salt directly through the loading hatches into the tank.

Dry salt storage bin. A few additions converted an existing dry salt storage bin into a rugged dual-unit Storage Lixator. Reinforced concrete was poured to make two 6-ft.-high salt-dissolving tanks in the bottom of the bin. Water inlet and brine discharge pipes, plus a few other necessary pieces of equipment, were installed . . . and the Lixator was ready to operate.

THE LIXATE PROCESS

. . . for making brine works like this: Sterling Rock Salt is stored in a tank called a Lixator. Water is admitted near the top. It flows *down*, dissolving salt as it goes. Soon fully saturated and unable to absorb more salt, this brine is completely self-filtered by the salt crystals in the bottom of the tank. The resulting Lixate Brine is exceptionally pure, clean, high in quality. As this brine is drawn off to points of use, more Sterling Rock Salt flows into the Lixator, and more water is admitted to produce more brine.


INTERIOR BIN SHEATHING ON TOP OF NEW PARTITION
STUDS
NEW CONCRETE PARTITION WALLS BUILT INTO PASSAGEWAY
EXISTING PASSAGEWAY WALL
INTERIOR BIN SHEATHING NOT SHOWN ON TOP OF THIS PARTITION
WATER DISTRIBUTION PIPE
EXISTING PASSAGEWAY WALL
BRINE COLLECTING DUCT
FLOAT BOX WITH FLOAT VALVE
WATER INLET
BRINE OUTLET TO PROCESS

SIMPLIFIED SCHEMATIC DIAGRAM OF A STORAGE LIXATOR BUILT INTO PASSAGEWAY WALLS

Unused basement area. A large industrial plant is now using a basement room to make clean, fully saturated Lixate Brine for water-softener regeneration. Here again, a reinforced-concrete tank makes the lower portion of the room into a watertight salt-dissolving and brine-storage unit. Dry Sterling Rock Salt is stored in the space above the salt-dissolving tank, and in the room directly over the Lixator.

Underneath a railroad trestle. One of the most dramatic Lixator installations is the conversion of the empty space under a railroad trestle. 70 ft. long, 18 ft. wide, and 12 ft. high, this extraordinary Storage Lixator can make thousands of gallons of Lixate Brine per hour. And salt delivery is entirely automatic: Sterling Rock Salt drops *directly* from railroad hopper cars on the trestle into the Lixator.

There are dozens of different Storage Lixators, converted, like the ones described here, from existing plant equipment . . . and tailored to the specific needs of each particular company. If your company could benefit from the conversion of unused space into a Lixator, be sure to contact International Salt Company. One of our experienced sales engineers can show you detailed plans of existing Lixators. He can also work with you to decide on the installation that will best meet your requirements.

To get this impartial technical assistance, contact your nearest International sales office, or write to us direct.

INTERNATIONAL SALT CO., SCRANTON, PA.
Sales Offices: Atlanta, Ga.; Chicago, Ill.; New Orleans, La.; Baltimore, Md.; Boston, Mass.; Detroit, Mich.; St. Louis, Mo.; Newark, N. J.; Buffalo, N. Y.; New York, N. Y.; Cincinnati, O.; Cleveland, O.; Philadelphia, Pa.; Pittsburgh, Pa.; Memphis, Tenn.; and Richmond, Va.

Service and research are the extras in **STERLING SALT**
PRODUCT OF INTERNATIONAL SALT COMPANY, INC.

PEOPLE . . .

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES

This Month's Top Projects:

W. R. Grace's Dewey & Almy Chemical Div. is starting construction on a $4-million organic chemicals and battery separator plant at Owensboro, Ky. New plant will more than double firm's capacity for vinyl acetate polymers and copolymers, and styrene-butadiene copolymer latices.

Georgia-Pacific Co. has started a new $2-million plywood plant at Coos Bay, Ore., that will have an annual capacity of 90 million sq. ft. Unit will be integrated with firm's sawmill operation there.

American Cyanamid has announced that it will start construction this summer on a multimillion-dollar maleic anhydride manufacturing plant at Bridgeville, Pa. Completion and operation are scheduled for late next year.

Brown Co., Berlin, N. H., now has its $5.5-million chemical recovery unit in continuous operation at the 400-ton/day Burgess pulp mill. Plant burns greater part of waste sulfite liquors, reclaims pulping chemicals and generates additional process steam.

Delhi-Taylor Oil Corp. is firming up plans for its projected $20-million potash mine and surface plant in Grand County, Utah. Company estimates that mining only 10% of its 25,000-acre holding will maintain a "major production rate" for 25 years. Construction will probably start next year.

Stauffer Chemical Co. is planning to erect a new plant for commercial production of its new herbicide, Eptam. Product is now being sold in limited quantities.

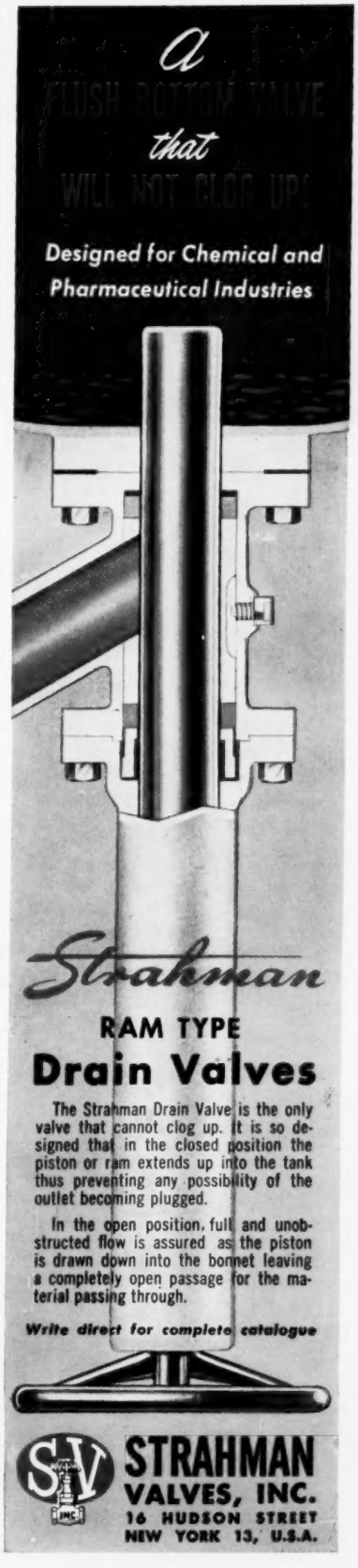
Imperial Oil has started engineering design on a $1.4-million asphalt plant with a 1,500-bbl./day capacity that will be built at firm's Edmonton, Alta., refinery. Plant is scheduled for operation by spring of 1959.

Great Western Sugar Co. has taken preliminary steps towards acquiring a suitable site in Chicago for erection of a delivery terminal for both bulk and liquid sugars.

Columbia-Southern Chemical Corp. has opened a new research center at its plant in Barberton, Ohio. Building is a multimillion-dollar structure containing 70,000 sq. ft. of floor space.

International Nickel Co. is erecting a new building at its Huntington, W. Va., Works that will house additional seamless tubing and other cold draw facilities, increasing capacity by 50%.

Girdler Construction Div. of Chemetron Corp. has been awarded a subcontract to design and build a hydrogen plant for the $45-million high-energy fuel plant which Olin Mathieson is constructing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that
Designed for Chemical and Pharmaceutical Industries
Strahman
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Drain Valves
The Strahman Drain Valve is the only valve that cannot clog up. It is so designed that in the closed position the piston or ram extends up into the tank thus preventing any possibility of the outlet becoming plugged.
In the open position, full and unobstructed flow is assured as the piston is drawn down into the bonnet leaving a completely open passage for the material passing through.
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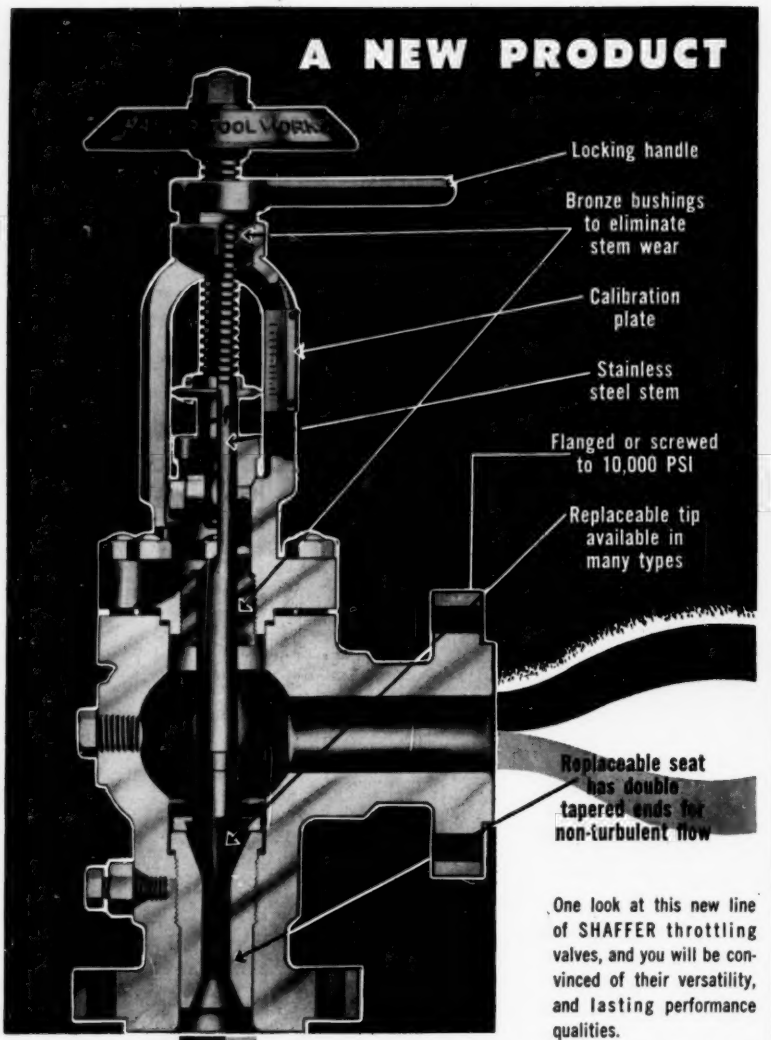
NEW YORK 13, U.S.A.

A NEW PRODUCT


Locking handle
Bronze bushings to eliminate stem wear
Calibration plate
Stainless steel stem
Flanged or screwed to 10,000 PSI
Replaceable tip available in many types
Replaceable seat has double tapered ends for non-turbulent flow

One look at this new line of SHAFFER throttling valves, and you will be convinced of their versatility, and lasting performance qualities.

AUTOMATIC THROTTLING or remote control with air motor, hydraulic motor, air or hydraulic cylinder, and are adaptable to any installation.

Manufactured by SHAFFER TOOL WORKS, pioneer in the oil tool industry, these valves incorporate many built-in features to fulfill the demands of grueling, continuous flow and metering. They are outside screw type for corrosion resistance, and are available in ASA or API standard pressure ratings to 10,000 PSI. All valves are furnished with a stainless steel stem in bronze mountings. Needle tips are interchangeable, and are available in many shapes, types and materials. STANDARD ORIFICE CHOKES are also available.

DOUBLE-TAPERED, venturi tube seat creates non-turbulent flow which virtually eliminates emulsification. Investigate the design and performance of this valve, which is setting new standards of performance wherever it is installed.

WRITE FOR FREE BROCH

SHAFFER

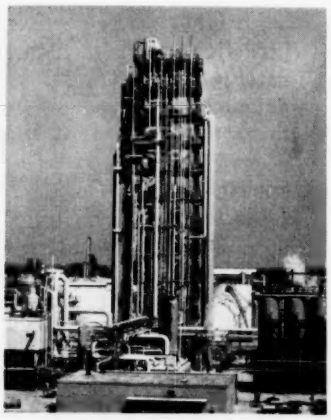
OOL WO S

209 S POMONA AVE. , CALIFORNIA, DEPT. CE-10

FIRMS . . .

for the Air Force at Niagara Falls, N. Y.

Petro-Tex Chemical Corp. is building a 2-million-gal./yr. high-purity isobutylene plant in Houston, Tex. Product will be above 99% pure, will be available in pressurized tank cars in December.



Esso has placed a new ethylene purification unit on stream at its big refinery in Baton Rouge, La. Most of output will be piped to plants in the Baton Rouge area for use as petrochemical raw material.

Shell Development Co. has dedicated a new research laboratory on its 142-acre experimental farm in Modesto, Calif., that will be devoted to finding new weapons to use in checking the annual U.S. crop damage loss of $13-billion.

Norwich Pharmacal Co. is embarking on an expansion of its manufacturing facilities at Norwich, N. Y., for making nitrofuran antimicrobial drugs. Cost: About $1 million.

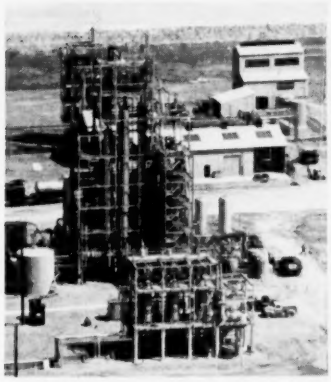
Leonard Construction Co., subsidiary of Monsanto Chemical Co., has received the construction contract for Fremont Minerals' new 125-ton/day sulfuric acid plant at Riverton, Wyo. Cost of plant will be about $750,000.

Sarco Co. announced that it is building a new factory wing

at its Bethlehem, Pa., plant for manufacturing steam traps. Addition will add approximately 50% to production capacity.

Solvay Process Div., Allied Chemical Corp., is beginning a modernization and improved materials-handling project at its Baltimore Mutual Chromium Chemicals plant. New equipment will permit rapid-automatic packaging of chromium chemicals.

Texas Eastern Transmission Corp. has started construction of an underground storage cavern for LPG at Lebanon, Ohio, 30 mi. north of Cincinnati. When completed, first cavern will hold more than 12 million gal.

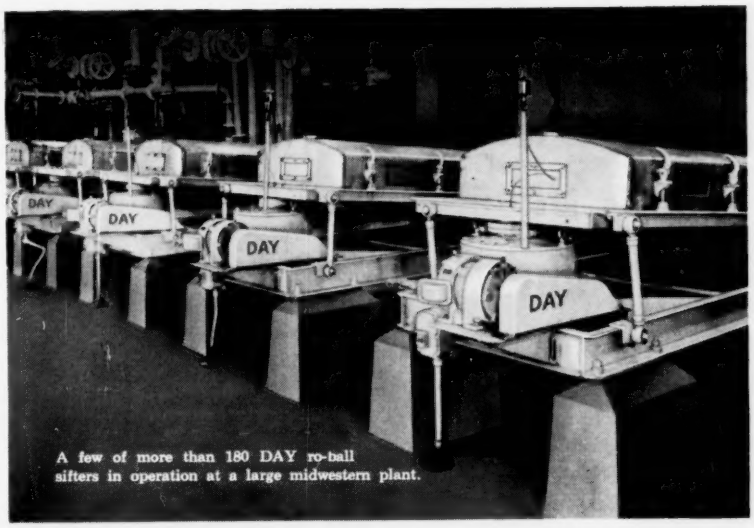


Air Reduction Co. is now producing methyl butynol via a new, and still-secret continuous process at a new plant in Calvert City, Ky. Unit, with 3-million-lb./yr. capacity, will also turn out methyl pentynol.

Memphis Mixed Products Terminal Corp. is completing a public liquid-warehousing facility on an 11-acre site in the Memphis, Tenn., Harbor. Tanks for petroleum jelly and liquid fertilizer have already been built; other tank construction will proceed with negotiation of contracts.

Atomic Energy Comm. is planning to build a $150,000 pilot plant to process and package radio-isotopes at the Hanford Works, Hanford, Wash.

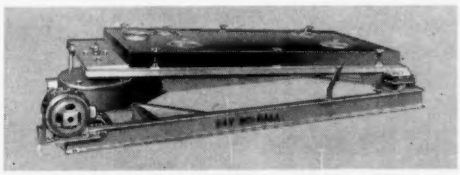
SIFT finer-faster-cleaner with DAY ro-balls

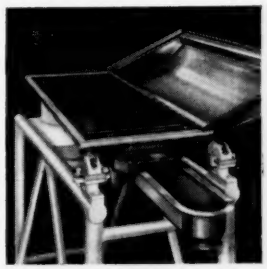


A few of more than 180 DAY ro-ball sifters in operation at a large midwestern plant.

Today thousands of products wet or dry, from flour to wood chips, are sifted through efficient, low-cost, high-production DAY ro-ball sifters. Superbly engineered, built for trouble-free operation under the severest service conditions, they insure longer life with lower maintenance costs.

The exclusive super active ball cleaning device provides rebound points in each ball compartment, assuring fast, thorough sifting of your product. Gyrating action brings material into constant contact with every square inch of screen surface. A stabilizer maintains screen in horizontal position and insures smooth operation.


DAY standard ro-ball, available in six sizes, single or multiple screens. Single screen models in stock.


Stainless steel units available to meet food and dairy sanitary codes.

Many models are available so it is easy to choose one which will exactly suit your requirements. They can be used separately or in combination with DAY mixers or blenders to save product handling. A completely equipped lab is available for testing your product.

Write for new DAY ro-ball Bulletin.

The **J. H. DAY** *Co.*

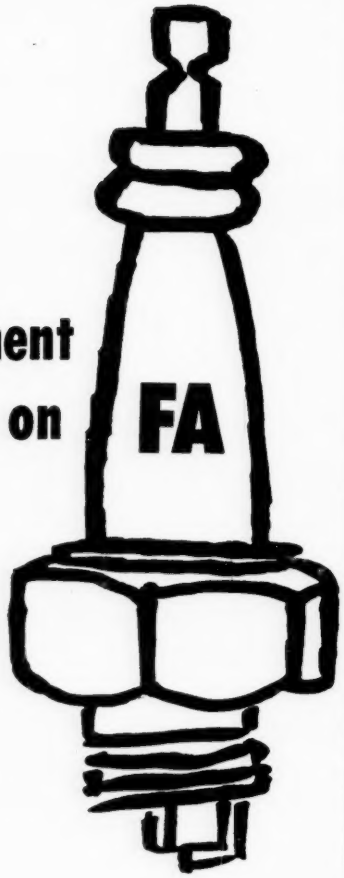
Division of The Cleveland Automatic Machine Co.

SERVING THE PROCESS INDUSTRY SINCE 1887

4926 Beech Street, Cincinnati 12, Ohio

A QUAKER OATS COMPANY NEWS BULLETIN

Product Development Starts and Runs on FA



For instance, Furfuryl Alcohol:

- **Resinifies to form corrosion resistant resins.**
- **Dissolves as well as reacts with many resins.**
- **Improves gap filling and craze resistant properties of urea adhesives.**
- **Wets mineral surfaces.**
- **Is a useful chemical intermediate.**
- **Disperses many difficultly soluble substances.**

Start your wheels turning by writing for Bulletin 205.

The Quaker Oats Company
CHEMICALS DEPARTMENT

335E The Merchandise Mart, **Chicago 54, Illinois**
Room 535E, 120 Wall Street, **New York 5, New York**
Room 435E, 48 S. E. Hawthorne Blvd., **Portland 14, Oregon**
In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England
In Europe: Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota," Copenhagen, S. Denmark
In Australia: Swift & Company, Ltd., Sydney
In Japan: F. Kanematsu & Company, Ltd., Tokyo

FIRMS . . .

Methods are being developed for extracting the isotopes from the large amounts of wastes stored underground.

MERGERS & ACQUISITIONS

National Distillers has leased from Stauffer Chemical, with an option to purchase, the latter's recently completed 50-million-lb./yr. titanium tetrachloride plant at Ashtabula, Ohio. Plant startup is expected to be completed by mid-summer, will supply Mallory - Sharon's sponge plant also at Ashtabula.

Kennecott Copper Corp. has handed over $20 million in cash to American Smelting & Refining for the latter's Garfield copper smelter near Salt Lake City, Utah. Actual transfer of title will not take place until Jan. 2. 1959.

Hooker Electrochemical Co. and Shea Chemical Corp., New York, N. Y., are firming up plans to consolidate the two companies, subject to stockholder approval. Under terms of agreement, Hooker will be continuing company and will change its name to Hooker Chemical Corp.

NEW COMPANIES

Arkansas Louisiana Chemical Corp. has been organized to build a plant at Magnolia, Ark., to process propane, butane and other natural gas products. Firm is currently trying to raise $2 million through a stock offering.

H. F. Wood Co. is a new firm marketing products for steel producing, steel fabricating, coal, paper and chemical industries.

CALENDAR

Heat Transfer and Fluid Mechanics Institute, University of California.
June 19-21 Berkeley, Calif.

American Institute of Chemical Engineers, 50th Anniversary Meeting, Bellevue-Stratford Hotel.
June 22-27 Philadelphia, Pa.

American Society of Testing Materials, annual meeting and exhibition, Hotel Statler.
June 22-27 Boston, Mass.

Forest Products Research Society, 12th national meeting.
June 22-27 Madison, Wisc.

Gordon Research Conference, Catalysis, Colby Junior College.
June 23-27 New London, N. H.

Gordon Research Conference, Coal, New Hampton School.
June 23-27 New Hampton, N. H.

Gordon Research Conference, Nuclear Chemistry, Kimball Union Academy.
June 23-27 Meriden, N. H.

Canadian Gas Association, annual meeting, Manor Richelieu Hotel.
June 24-27 Murray Bay, Que.

Society of the Plastics Industry, Midwest Section conference, French Lick-Sheraton Hotel.
June 26-27 French Lick, Ind.

Gordon Research Conference, Polymers, Colby Junior College.
June 30-July 4 New London, N. H.

Society of Chemical Industry, Exeter Conference, University of Exeter.
July 7-11 Devonshire, England

Gordon Research Conference, Organic Coatings, New Hampton School.
July 7-11 New Hampton, N. H.

Gordon Research Conference, Chemistry and Physics of Isotopes, Kimball Union Academy.
July 7-11 Meriden, N. H.

American Oil Chemists Society, Princeton Inn.
July 14-18 Princeton, N. J.

Gordon Research Conference, Corrosion, Colby Junior College.
July 14-18 New London, N. H.

Gordon Research Conference, Organic Reactions and Processes, New Hampton School.
July 14-18 New Hampton, N. H.

American Farm Research Conference, Purdue University.
July 16-18 Lafayette, Ind.

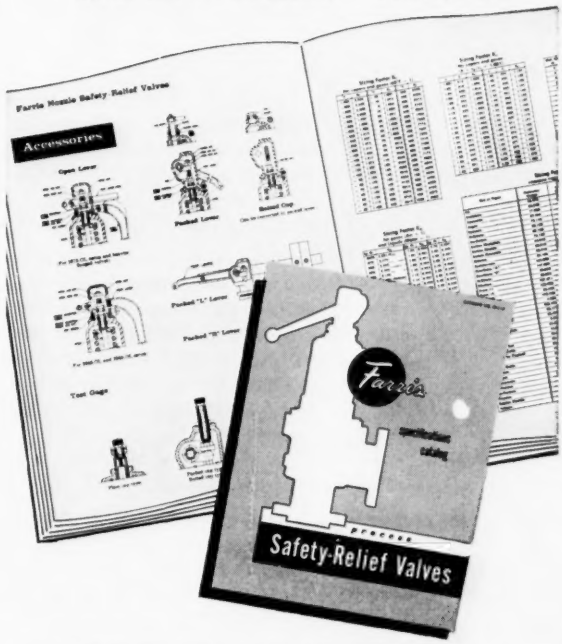
Technical Association of Pulp and Paper Industry, 13th engineering conference, Multnomah Hotel.
July 28-August 1 Portland, Ore.

Gordon Research Conference, Instrumentation, Colby Junior College.
July 28-Aug. 1 New London, N. H.

Gordon Research Conference, Elastomers, Colby Junior College.
Aug. 4-8 New London, N. H.

JUST RELEASED!

New FARRIS Reference Catalog Simplifies Selection and Sizing of Process SAFETY-RELIEF VALVES



CONTENTS INCLUDE

- Complete data on all Farris Standard and BalanSeal valves for process piping
- Special materials for chemical and low temperature service
- Safety-relief valve accessories
- Sizing formulae and factors
- Sizing factor curves for over pressure and back pressure
- Nozzle capacities for water, air, steam, vapors and gases
- Dimension and weight tables

Your copy of the new Farris process Safety-Relief Valves catalog is available immediately. Write today, requesting Catalog FE-118.

PROGRESS THROUGH HONEST PURPOSE — Farris ENGINEERING CORP.
501 Commercial Avenue, Palisades Park, N.J.
In Texas: 5405 Clinton Drive, Houston 20

AFFILIATES: Farris Flexible Valve Corp. • Farris Pickering Governor Co., Inc. • Farris HydroSeal Corp. • Farris HydroTorque Corp.

EASTERN MIXERS

mix fluids quickly . . . thoroughly

EASTERN'S COMPLETE LINE of fluid mixers range from fixed-mounted 40 H.P. turbines and heavy-duty propeller mixers to lightweight portables. Where fixed-mounted installations are not required, Eastern Portables offer versatility, ease of handling and long-term cost savings.

Portables are available with speeds of 420, 1125 and 1725 R.P.M., rated from 1/20 to 3 H.P. as standard, with variable speed and air-driven models also available. Motors in all standard types can be supplied in open drip-proof, totally-enclosed, or explosion-proof construction. Shafts and single or dual propellers are available in a choice of alloys for all service requirements. New optional ball-swivel clamp as illustrated, permits easy adjustment of mixer position in tank.

For a personalized analysis of your mixing problems, send details to Eastern engineers. A recommended solution will be furnished promptly and without obligation. For a helpful guide to mixing fundamentals, write for "Handbook of Fluid Mixing."

SIDE-ENTERING MIXERS Handle the extra heavy-duty jobs in big tanks. Sizes ¼ to 30 H.P. Send for Bulletin 620.

TOP ENTERING MIXERS Designed for heavy-duty applications requiring agitators from ¼ to 10 H.P. Send for Bulletin 620.

TURBINE MIXERS Range of ¼ to 40 H.P. solve many special mixing problems. Send for Bulletin 1210.

NEW PORTABLE MIXER BULLETIN

Eastern's improved line is included in the revised Bulletin No. 530.

Eastern INDUSTRIES, INC.

Dept. A-3, Norwalk, Conn.

PEOPLE . . .

MEET YOUR

P. W. Eatman

MENTAL FATIGUE CAN SABOTAGE YOUR SUCCESS. PAGE 191.

This issue's YYJ author has many interests in life but if he had to single out one as a primary concern he would point to his interest "in people, of all kinds and in all walks of life."

Says Eatman, "They are the creators of engineering advancement and its purpose. Our plant and machines mirror their successes, failures, whims and personalities."

As a part of this interest, Eatman began to take note of how men work and to speculate about how they might work better. So, the crippling effects of mental fatigue and their possible remedies got a lot of attention.

P. W. Eatman earned his B. S. in chemical engineering after two years and a summer session at Louisiana State University. That was after he had spent three years at Centenary College of Louisiana studying pre-law and science.

Early employment record lists the J. B. Beaird Co.; Celanese Corp. of America, as a chemical engineer in research; and Fomac Engineers, petroleum consultants, as a process engineer. In 1949, he joined Eastern States Petroleum Corp. as process engineer. Since 1951, he has been with Fluor Corp. Ltd., mid-continent division, Houston, Tex., as process engineer.

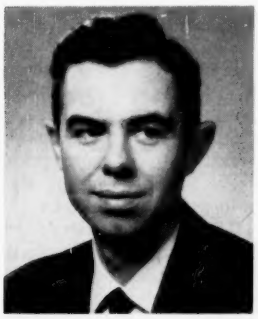
Professional memberships include the AIChE and Alpha Chi Sigma. He is also a registered

AUTHORS...

M. A. GIBBONS

professional engineer in the State of Texas.

As we said before, Eatman's interests are many and just to show you how widely they range, we'll hit the highlights: philosophy, religion, books, business organization, writing, fishing, modern music, psychology and—especially — fixing mechanical things. (Finding the causes of trouble and correcting them is always a challenge.)



W. W. Mitchell

USE SALT WATER COOLING TOWERS. PAGE 181.

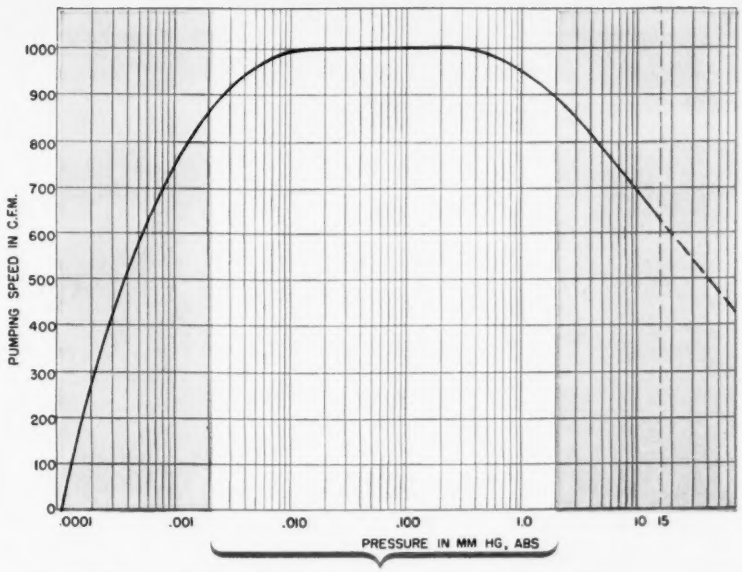
Standard Oil's W. W. Mitchell works as a lead engineer in the civil and architectural division of the firm's engineering department, in San Francisco, Calif.

Mitchell participated in the cooling water supply studies for the California Oil Co. which he refers to in the current article and helped in the planning and design of the salt water cooling towers.

He joined Standard Oil of California in 1947, right after graduation from school, to perform design work primarily in the field of civil engineering.

Educational background includes a B. E. civil engineering degree from Yale University.

Mitchell commutes daily to work from San Mateo, Calif., where he lives with his wife and daughter. He hold a commission in the Naval Reserve, which he obtained in the NROTC while at Yale, and is a registered civil engineer in the State of California.



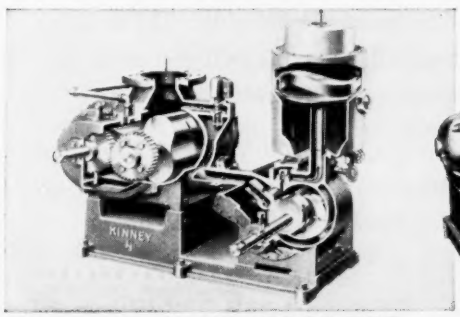
Do You Use Vacuum In This Range?

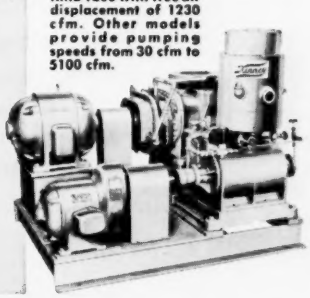
From millimeters to microns . . . in this region the significant economy of the KINNEY KMB Mechanical Booster Pump is self-evident, as shown by the performance curve above. And, this high efficiency is doubly attractive because these KINNEY Pumps provide *clean, dry* Vacuum . . . no backstreaming . . . automatic operation . . . no stalling problems from gas bursts.

Kinney®

MECHANICAL BOOSTER HIGH VACUUM PUMPS

The KINNEY KMB Pumps have proven themselves in the most difficult applications. Their performance, even where outgassing of materials renders other pumps inoperative, stamps them as the major contribution of the decade in High Vacuum service. Models range from 30 to 5100 cfm free air displacement.





KMB 1200 with free air displacement of 1230 cfm. Other models provide pumping speeds from 30 cfm to 5100 cfm.

WRITE for Bulletin No. 400A It's FREE

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Please send me copy of Bulletin No. 400A describing KINNEY KMB High Vacuum Pumps.

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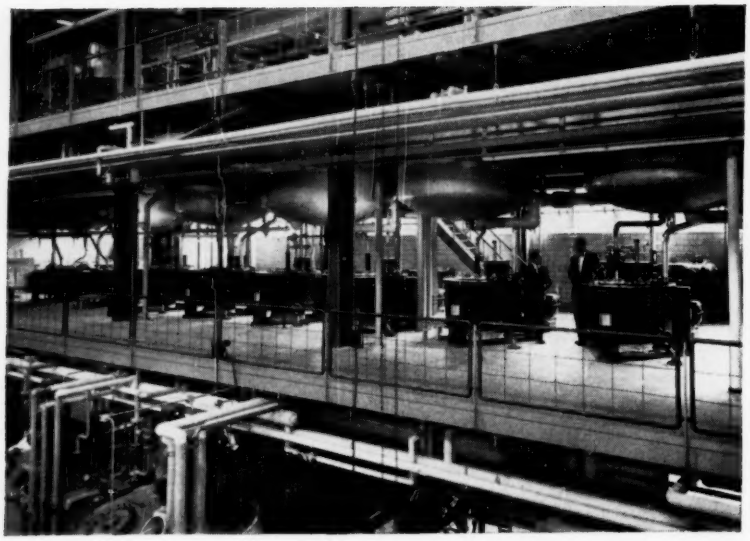


Labor savings will pay for these 6 new BATCH-MASTERS® in less than 2 years

Nutley, N. J. — In expanding its production facilities for Gantrisin, one of their sulfa group pharmaceuticals, Hoffmann-LaRoche, Inc., had the option of selecting nine 48″ conventional centrifugals or six 48″ Tolhurst Batch-Master® machines.

After considering that only one man is required to tend each two "Batch-Masters," while four men are needed for every three conventional units, the manufacturer decided on the former machines. The resulting 75% labor savings will offset the total cost of the new machines in approximately 18 months.

The "Batch-Master's" fast bottom discharge and hydraulic unloading make the difference in labor requirements and in batch processing cycle time.

FOR MORE COMPLETE DATA, SEE TOLHURST'S SECTION IN CHEMICAL ENGINEERING CATALOG or write

Tolhurst CENTRIFUGALS

A DIVISION OF

American Machine and Metals, Inc.

Dept. CET-658, EAST MOLINE, ILLINOIS

SPECIALISTS IN LIQUID-SOLIDS SEPARATION

PEOPLE . . .

TECHNICAL

New Gmelin Volumes

GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY. Issued by the Gmelin Institute, Verlag Chemie, Publishers, Weinheim, Germany. Available from Walter J. Johnson Inc., 111 Fifth Ave., and Stechert-Hafner Inc., 31 E. 10 St., New York 3, N. Y.

Reviewed by M. Wulfinghoff, Consulting Engineer, Erlanger, Ky.

Calcium. (System No. 28, Part B, Section 2, xvi and 392 pages. $52.56). The first 12 pages of the current text cover the hydrides of calcium and give a review of available data through 1949.

Oxides cover 20 pages; hydroxides and peroxides, 23 pages. The nitrides, the azide, imide and amide take 11 pages.

The Ca-NH_3 system, the compound $Ca(NH_3)_6$, the salts of the oxygen acids of nitrogen and the more complex systems are dealt with on 51 pages.

Next are the fluorides (whose solid-type behavior, as crystallographic properties, are of significance) and other halogens.

There is a wealth of information on the physical and chemical characteristics of aqueous and non-aqueous solutions. $CaCl_2$ refrigerant solutions are discussed thoroughly, as are the industrial aspects of chloride of lime, and calcium sulfide.

Copper. (System No. 60, Part B, Section 1, xxvii and 624 pages. $83.76.) The first 23 pages of this volume deal with the hydrides. Oxygen compounds take 114 pages. Fifty-six pages are devoted to the nitrogen compounds, 293 to the halogen compounds, 168 to sulfur compounds, 18 to the selenium compounds, and six pages to the tellurium compounds.

Special attention is given to the azides, hydroxide, nitrate, chloride and sulfates.

Very fully treated are the compounds of monovalent copper, particularly the oxide and sulfide (Cu_2O, Cu_2S) and the halides, as well as those basic cop-

BOOKSHELF

J. B. BACON

per (II) salts of which the chloride atacamite is an example.

In the case of compounds which occur in nature as minerals, the properties of both such minerals and the synthetic products are presented. Pertinent literature has been covered in general up to 1954, and in full up to the end of 1949.

Systematic Subject Index. (xiv and 116 pages. $17.28.) This bilingual (English and German) classification of subject matter in inorganic chemistry and related fields includes code numbers for machine-documentation systems.

It contains all headings as they appear in the Gmelin series, and has been carefully prepared, systematized and reviewed.

In itself it should be valuable as a reference work for anybody active in international science, whether researcher, translator, teacher or analyst. It is recommended as an important adjunct to every user of technical and scientific dictionaries.

BRIEFLY NOTED

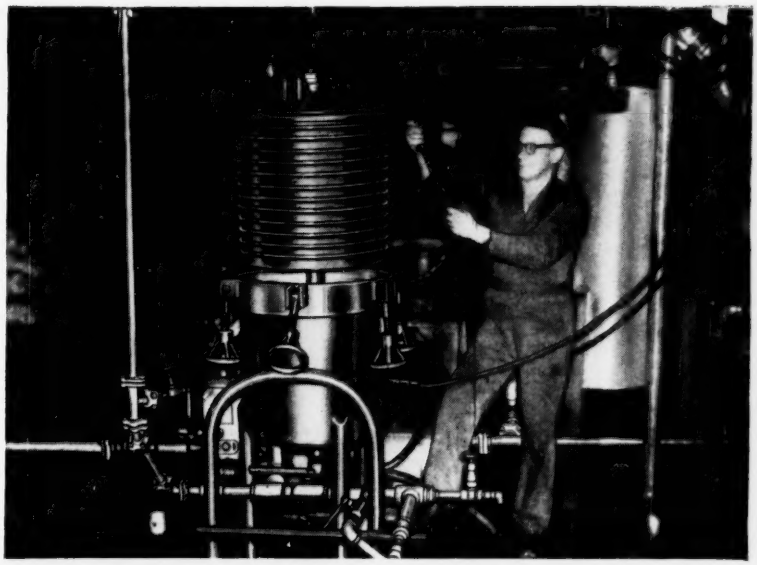
DIRECTORY OF INDEPENDENT COMMERCIAL LABORATORIES PERFORMING RESEARCH AND DEVELOPMENT, 1957. 59 *pp. National Science Foundation. Superintendent of Documents, Government Printing Office, Washington* 25, *D. C.* 40¢. Lists 565 laboratories, together with names of senior officers, numbers of research staff and types of research activities.

BULK COMPRESSIBILITY OF POLYMERS AT FABRICATING TEMPERATURES. 25 *pp. By B. Maxwell and S. Matsuoka, Signal Corps, U. S. Army. Order PB* 131334 *from Office of Technical Services, U. S. Department of Commerce, Washington* 25, *D. C.* 75¢. Studies compressibility of amorphous and crystalline polymeric substances.

MORE NEW BOOKS

GAS DYNAMICS. By Ali Bulent Cambel and Burgess H. Jennings. McGraw-Hill. $11.

FUNDAMENTAL CONCEPTS OF INORGANIC CHEMISTRY. E. S. Gilreath. McGraw-Hill. $7.50.



Filter downtime cut 50%

and there's no scavenging necessary

THAT'S THE REPORT from Mr. G. E. Bradly, Jr., Assistant Factory Manager for Vanderbilt Chemical Co. at Bethel, Connecticut, on his experience with a new Niagara Batch-Miser® filter.

After cleaning, this Niagara Filter is *back on stream in minutes*. That's because disassembly, cleaning, and reassembly are made far easier by Niagara's advanced design which eliminates tie rods.

There's *no separate scavenging operation* with this Niagara Filter either. Downtime is reduced, and there is no liquid heel left at the end of the filtration cycle.

With Niagara Filters you can realize similar savings in your plant. First step — consult the Chemical Engineering Catalog for facts on Niagara Filters, or write us today, outlining your requirements.

Niagara® FILTERS

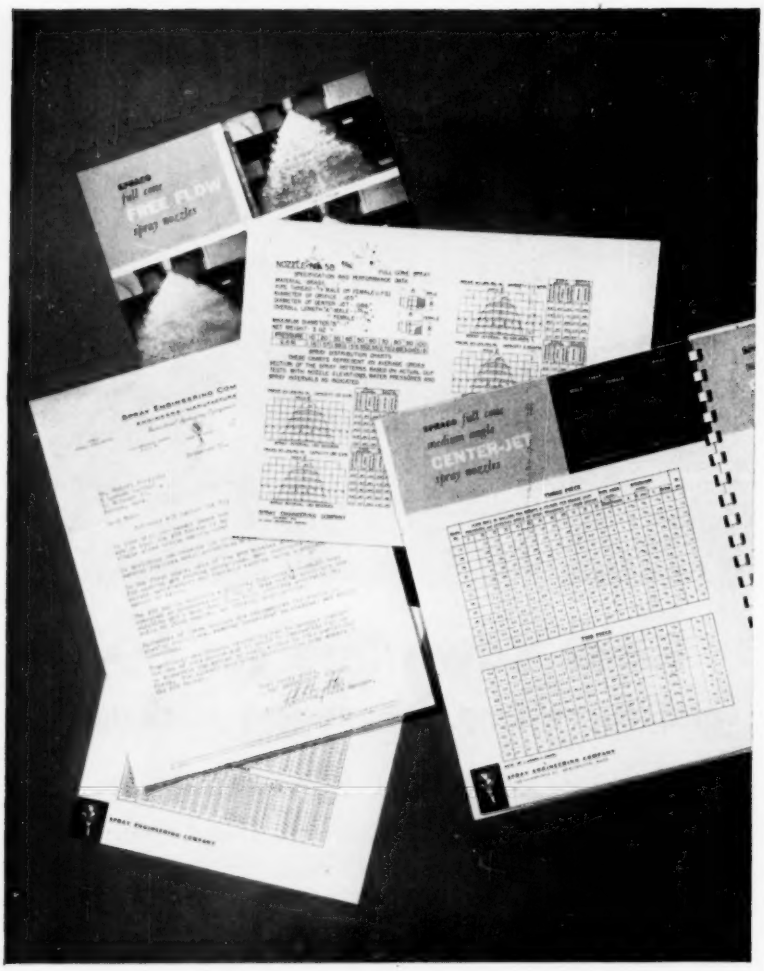
A DIVISION OF

American Machine and Metals, Inc.

Dept. CEN-658, EAST MOLINE, ILLINOIS

(Niagara Filters Europe: Kwakelpad 28, Alkmaar, Holland)

SPECIALISTS IN LIQUID-SOLIDS SEPARATION



NOW... "SPECS" AT YOUR FINGERTIPS

Here's a surer, easier way to specify spray nozzles

How can you be sure you're specifying the *right* spray nozzle for your particular application?

Spraco's research department has taken the guesswork out of this problem by preparing complete and accurate performance data for each of the hundreds of spray nozzles in the Spraco line. Each nozzle "profile" is complete with data on material, dimensions, flow rate, pressure, angle of spray . . . everything you need to enable you to choose, at a glance, the nozzle that will deliver maximum performance and efficiency in your particular application.

No matter what your spray nozzle problem, Spraco makes this information available to you absolutely free. Why not write and ask about it — today?

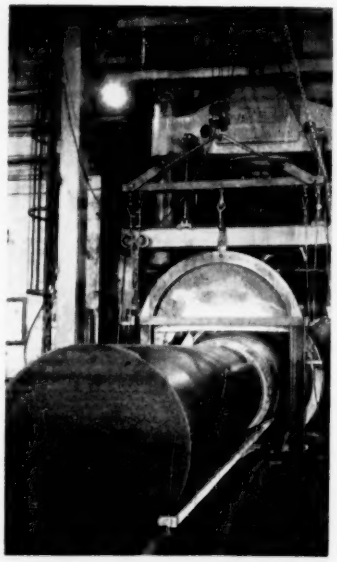
SPRAY ENGINEERING COMPANY

115 Cambridge Street, Burlington, Mass.

SPRACO

PEOPLE . . .

LETTERS:



Curiosity Now Satisfied

Sir:

Your recent Process Flowsheet for making giant electrodes (Apr. 7, pp. 128-131) was of particular interest to us at Barrett. As a major producer of electrode pitch, we have often been curious as to what the end product looked like and how it was made. Your article did a fine job of telling us.

HAROLD I. GOLDSMITH
Barrett Div.
Allied Chemical & Dye Corp.
Chicago, Ill.

Professional vs. Employee

Sir:

May I take gentle issue with you on a point which may seem picayune to many readers, but which I feel deserves serious consideration?

In your Feb. 10 issue (pp. 181-2) you published a letter from me on the subject of decimal filing systems. In its published form the letter is signed "A. C. Malmsten, Dow Chemical Co., Midland, Mich." I actually signed my original letter "A. C. Malmsten, PE, 4901 Harding St., Midland, Mich.", making no reference whatsoever to Dow.

I wrote that letter in my capacity as a Professional Engi-

PRO & CON

C. H. CHILTON

neer, not as an employee of Dow Chemical Co. Although I am currently employed by Dow, I actually developed my filing system during a period when my employer was Pennsalt Chemicals. However, this fact is of little significance. Of more significance is the fact that I evolved my private filing method, not because it was required by my employer or essential to the successful performance of my duties, but because it contributed to my professional development.

I feel compelled to say that an engineer cannot be professional, in the best sense of the word, if he permits his identity to become completely submerged in that of his employer.

If engineers themselves do not recognize — and insist upon — a clear distinction between their "professional" activities and their activities as an "employee," by what reasoning or right can they expect their employers to recognize it?

A. C. MALMSTEN

Midland, Mich.

▶ *We disagree with Mr. Malmsten that any engineer can clearly separate his professional responsibilities from those of his employment.*

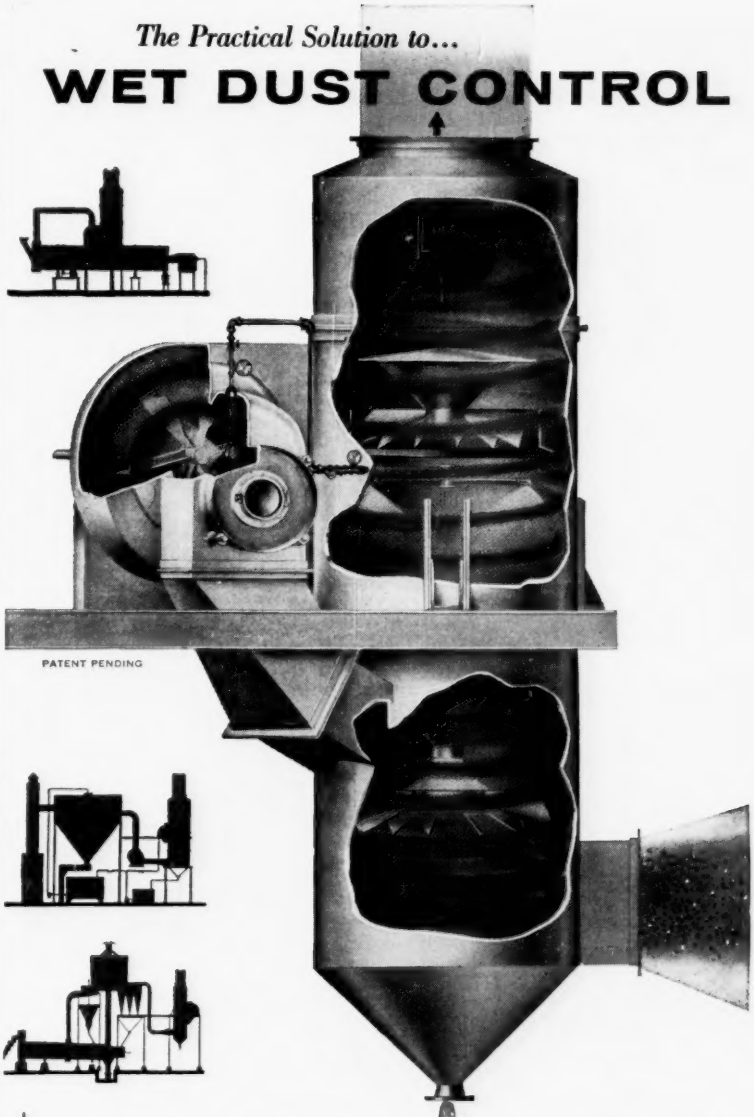
Carrying Mr. Malmsten's point to its logical conclusion means that professional journals would refrain from identifying the company connections of their authors, that professional societies would likewise refrain from identifying the employers of engineers presenting papers at meetings.

In case you're wondering how we tied Mr. Malmsten into Dow, it was easy. His letter, while written on plain stationery, arrived in a Dow envelope.

Incidentally, if Messrs. W. F. Wilhite and E. A. Brigham are in our reading audience, will they please identify themselves? We have received from them a worthwhile letter apparently intended for publication in this department. However, they neglected to give a return address, and the envelope was detached before it reached our desk, so we don't even have a postmark to go by. Since we refuse to publish anonymous letters, we hesitate to publish a letter not bearing the sender's address.—ED.

The Practical Solution to...

WET DUST CONTROL



The Ducon Centrifugal Wash Collector, Type UW-4, is a basic air scrubber with extensive applications for the wet principle collection of problem dusts and recovery fines. For maximum collection efficiency of extremely fine dusts under the most varied conditions... such as in high dust loading and for abrasive dusts... this unit has proved unexcelled in many types of industrial processes. Unitized construction, precision shop-fitted parts and integrated fan assembly provide simple, rapid installation into the normal processing system.

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PEOPLE . . .

NAMES IN

Men of the Month:

T. H. Chilton
J. V. N. Dorr
O. A. Hougen
S. D. Kirkpatrick
W. K. Lewis

The AIChE presents its new Founders Award to five outstanding leaders of the chemical engineering profession.

This month, as the AIChE takes nostalgic stock of its 50 years of service to the field it serves, it takes special notice of men in the field who have "made outstanding contributions to the profession of chemical engineering and who have had a long and distinguished record of service to that profession."

These men will be honored next Monday, June 23, as first recipients of the AIChE's new Founders Award, to be presented during the Society's 50th Anniversary celebration in Philadelphia, at a special ceremony.

The recipients are T. H. Chilton, J. V. N. Dorr, O. A. Hougen, S. D. Kirkpatrick and W. K. Lewis.

T. H. Chilton is technical director of DuPont's development engineering division, engineering department.

In a year or so, however, Chilton will take advantage of the firm's 30-year service retirement proviso and devote his energies to engineering education. Specifically, he plans to spend a year at a time at various institutions wherever he can be of the most service.

Past recognition of his outstanding service to the profession has included the vice presidency and the presidency of the AIChE and the privilege of wearing the "iron ring" of the Engineering Institute of Can-

THE NEWS

M. A. GIBBONS

ada as well as many medals.

Chilton joined DuPont at the experimental station in 1925 to take on chemical engineering assignments in ammonia oxidation and sulfuric acid process development. In 1930, he was put in charge of a research group on unit operations.

In 1938, he became director of the technical division of the engineering department and by 1945, he was named manager of the development engineering division of the department. He became technical director of the development engineering division in 1946 and was named to his present post early this year.

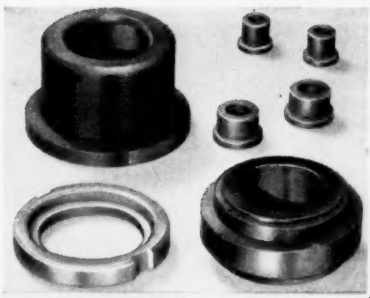
John Van Nostrand Dorr, tireless inventor and recipient of countless awards, is honorary board chairman of the Dorr-Oliver Co. Many years ago, he himself founded one of the firm's industrial predecessors—The Dorr Co.

Among his many inventions are the Dorr classifier, the Dorr thickener, Dorr agitator and the continuous counter current decantation.

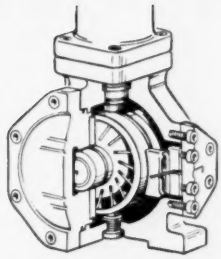
In 1941, Dorr earned the Perkin Medal of the Society of the Chemical Industry for his work in applied chemistry. Two years later, the honorary degree of doctor of science was conferred on him by Columbia University for his "contributions to metallurgical, sanitary and chemical engineering as an engineer, inventor and administrator.' On the occasion, Columbia also stated that "the methods and processes sired by Dr. Dorr's basic metallurgical inventions have found widespread usage throughout the chemical and allied industries . . ."

Dorr graduated from Rutgers University in 1894. Some years later, he earned a master's in engineering and in 1927 Rutgers awarded him the honorary degree of doctor of science.

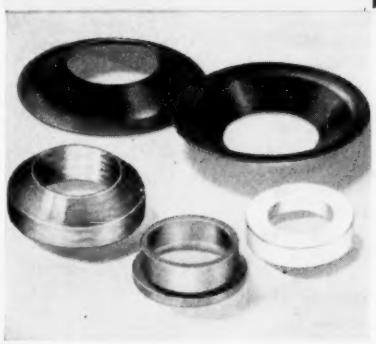
O. A. Hougen, internationally known for his scholarship and



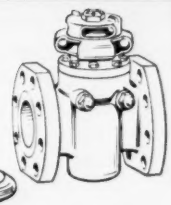
FOR:
Guide Bushings, Vanes and Wear Rings

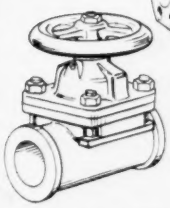


HAVE YOU CONSIDERED THE IMPORTANT ADVANTAGES OF FILLED TEFLON*?



Formed Gaskets





Valve Seats and Packings

It has been definitely established that the value of Teflon can be considerably enhanced by the use of fillers in certain applications. Laboratory and field experience has demonstrated that the use of fillers permit Teflon to be more readily tailored to a wide variety of chemical, electrical and mechanical applications. Also, some mechanical properties can be improved. These include:

1) resistance to deformation under load
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3) thermal conductivity
4) compressive strength
5) hardness

By thus improving its properties, Teflon now offers even greater industrial potential. This is the reason filled Teflon has become an important item in the "John Crane" Chemlon® line of better Teflon products.

Chemlon is available with such fillers as glass fiber, carbon, graphite, copper and bronze, talc, calcium fluoride and other inorganic materials.

Tell us about your requirements. We'll tell you the advantages you can get from filled Chemlon. Request Bulletin T-104.

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NAMES . . .

as an educator, is a professor of chemical engineering at the University of Wisconsin. He has taught at the school for the past 37 years.

Last year, however, Hougen spent five months in Japan as a Fulbright professor in chemical engineering. During that time, he taught at Kyoto University, lectured before sections of the Japan Society of Chemical Engineers and visited various firms and universities. On his way back to the States, Hougen repeated this round of activities in India and in Taiwan. In India, he also served as a foreign delegate to the Indian Congress of Science.

Just three years ago, Professor Hougen was awarded the first annual Benjamin Smith Reynolds Award of $1,000 for "excellence in the teaching of future engineers." In 1951, he lectured in chemical engineering at Norway's large technological school at Tronheim—also under the Fulbright program.

Sidney D. Kirkpatrick is editorial director of Chemical Engineering as well as of Chemical Week and a vice president of the McGraw-Hill Book Co.

Biggest chunk of his career, however, was spent as editor of CE and its predecessor Chem & Met for 22 years (1928-1950).

In 1942, Kirkpatrick was named president of the AIChE and served three terms on the board of directors besides. In 1945, he also became president of the Electrochemical Society.

He served in both World Wars and, just before VE Day, he was made an assimilated Brigadier General to serve with the Technical Industrial Intelligence Information Committee in Europe. What's more, he was also named chairman of the AEC's advisory committee for industrial information.

In 1945, Kirkpatrick was awarded the Chemical Industry medal of the Society of the Chemical Industry. He is best known for his work on behalf of chemical engineers, the development and recognition of the chemical engineering profession, and for his service to the field as a journalist.

A word to the refractory-wise on . . .

How to make good use of bad times

Remember how management not long ago kept pressuring for "more production." There was no time then for analyzing productive efficiency. So a mild recession isn't all bad . . . *if it gives you badly needed time*—time to spot areas where you can cut operating costs.

For instance: It's highly probable that there are several areas where you could save by substituting one of our special-purpose refractory materials. Especially in "vulnerable" areas exposed to flames, abrasion, corrosion, high heat or heavy loads. Or, in "working" areas where the heat must pass *through* the refractory evenly and rapidly.

For example: One of our customers replaced a high molybdenum alloy cover for a pump handling an abrasive acid slurry with a REFRAX® nitrided silicon carbide cover. The new cover shows practically no wear at all after nearly 2 years in service, while the metal part was severely eroded in less than 6 months. In a separator used to recover fine coal fractions from gritty slimes, heavy wear due to erosion was a problem until a lining made of CARBOFRAX® silicon carbide material was used. Wear is now negligible. In another application, the high heat transfer of CARBOFRAX parts is utilized to dissipate heat with such success that far greater efficiency results. The examples are countless—as are the variety of materials applied.

Here's how you can start cutting costs: It will take less than an hour to read these two booklets about the applications—**and properties**—of Carborundum's unique, new super refractories. Send for them today.

Subscription to "Refractories" is yours for the asking. This technical brochure is published approximately every other month; contains a wealth of information on new refractory materials, lining techniques, etc. Offer limited.

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EROSION? A water solution of SO_2 passes through the stainless steel pipe (right) and into the REFRAX® nozzle (left) which sprays it into a cooler, as a step toward making sulphuric acid. Ambient temperature is 1800°F. Note the untouched look in the REFRAX nozzle's threaded section, and compare it with the stainless steel.

ABRASION? This elbow is part of an air conveyor system handling finely divided cement and asbestos. The charge, at about 150 to 200°F, is highly abrasive. Rubber linings originally used cut through in less than six months. CARBOFRAX® cylinders lining the elbow shown above, despite a service period of 2½ years, are free of pitting and other wear.

ATMOSPHERES? This furnace is heated to 3000°F by moly wire wrapped around the muffle. The muffle is made of our fused aluminum oxide—and insulated with our granular alumina "bubbles." These refractories have proved stable and durable—are not even affected by hydrogen or cracked-ammonia atmospheres.

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with positive control
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Where there's a valve leak, there's a profit leak. Hills-McCanna Diaphragm Valves give positive control on throttle or cut-off —for liquids, gas, corrosive services, slurries, air, and water. This packless, tri-component valve with exclusive sealing bead diaphragm assures leaktight closures.
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But Sid is known and loved on a personal basis for his amazing ability to keep track of the varied interests of countless colleagues and to pass along help or encouragement to further their progress.

Warren K. Lewis is a professor of chemical engineering (emeritus) at Massachusetts Institute of Technology. Lewis earned his own degree in the field of science at MIT in 1905. Later, he studied at the University of Breslau, Germany, where he was awarded a doctorate in 1908. He began an assistantship at MIT immediately after graduation and when he returned from Europe he became a research associate. In 1910, he officially began his career on the teaching staff of the Cambridge school.

Over the years, Lewis has authored or co-authored numerous articles and books in the chemical engineering field.

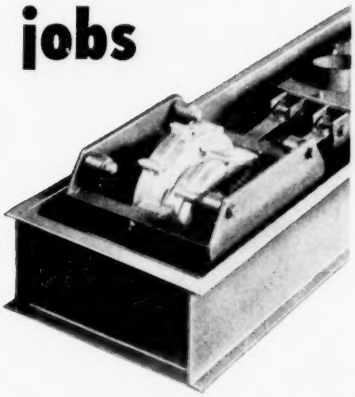
In 1936, he was awarded the Perkin Medal and in 1947, he earned the Lamme Medal as well as the Priestly Medal.

Donald D. Pascal

Donald D. Pascal has been appointed president and chief administrative officer of National Starch Products Inc. Formerly executive vice president, Pascal replaces Frank Greenwall who has been elected chairman of the board and chief executive officer of the company.

A chemical engineering graduate of Polytechnic Institute of Brooklyn, Pascal joined National Starch as a laboratory assistant in 1929. Since that time he has served in various areas of the company's activities, including

check these extra jobs



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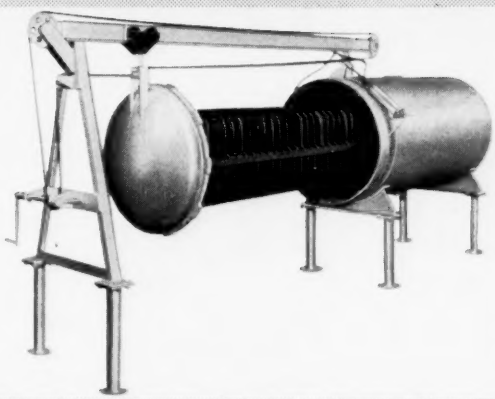
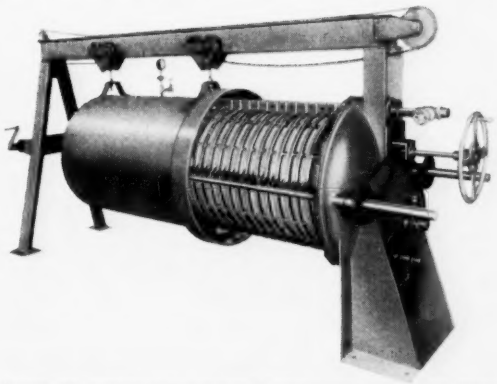


Horizontal Tank Vertical Leaf

For large volume clarification and for quick cake discharge. Made in full range of tank sizes and filter areas in steel and stainless steel.

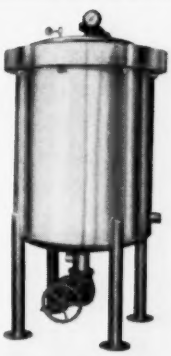
Horizontal Tank Vertical Leaf and Frame

Modification of above filter to allow use of paper and other filter media in sheet form; for high polishing filtration.



Vertical Tank Vertical Leaf

For rapid precoat clarification of liquids with low solids content. Wide range of sizes and selection of materials of construction.



There's a pressure leaf filter that's economically right for your process. Bulletin 146 tells why and how.

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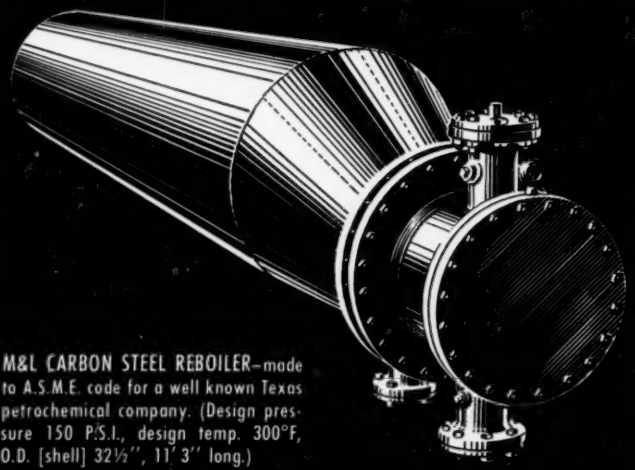

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Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

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vice president — sales, technical director and general manager of National Starch's Midwest division.

Reginald N. Blaize, Jr.

At the annual stockholders' meeting of Eastern States Petroleum & Chemical Corp., Reginald N. Blaize, Jr. was elected president and chief operating officer of the company.

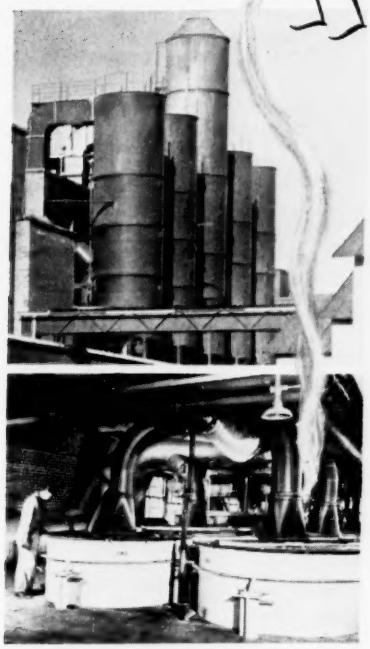
Blaize's entire business career has been spent in various phases of the oil industry. After receiving his chemical engineering degree from Louisiana State University he was employed by Lion Oil Co. in El Dorado, Ark., until he came to Eastern States engineering department in 1940 where he was soon appointed chief engineer.

Not long after his appointment as chief engineer, Blaize was promoted to manager of refining. In 1950 he was elected executive vice president, a position he held until his recent election.

Olaf P. Jenkins is now associated with Carrol E. Bradberry & Associates, Los Altos, Calif. Jenkins was formerly state mineralogist and chief of the Division of Mines, state of California, as consultant in economic geology.

Donald J. C. Koestler, Donald C. Garaventi and **Lester Cohen** are first, second and third-prize winners, respectively, of the annual F. C. Zeisberg Memorial Award for excellence in report writing by students in chemical engineering. Koestler is a senior chemical engineering student at Villanova University; Gar-

ACID VAPORS Strangled by MULTI-WASH



These vats are giving off harmful acid vapors that could affect workers' efficiency and contaminate air in the neighborhood.

The management of this plant has eliminated these dangerous vapors and the health hazard by using efficient Multi-Wash Collectors.

Each vat is hooded to take away vapors to special Multi-Wash units, lined with acid resistant material to prevent corrosion. There, acid vapors are mixed with a neutralizing liquid to render them harmless.

If your process presents problems in obnoxious vapors, fumes or dusts, contact your local Schneible representative or call us direct.

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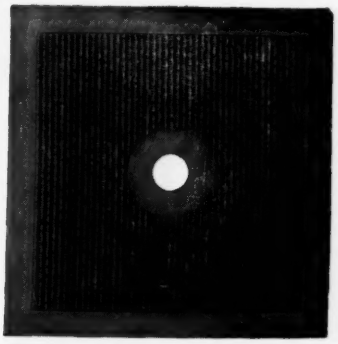

Are you using wire cloth or wire cloth parts which must be corrosion resistant? Are the service conditions in your plant really tough? If you have a problem selecting the proper anti-corrosive alloy, Newark Wire Cloth may have the answer.

Available in all corrosion resistant metals, Newark Wire Cloth is accurately woven in a wide range of meshes, ranging from very coarse to extremely fine.

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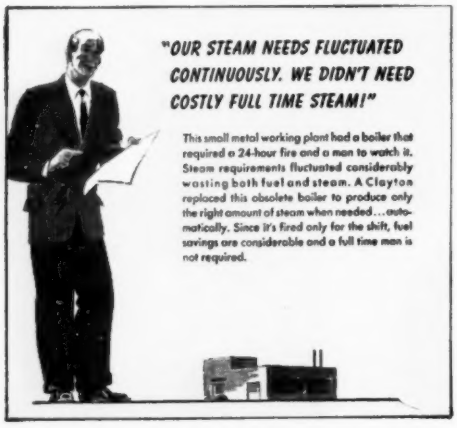
How a Clayton STEAM GENERATOR

"WE WERE FACED WITH AN OBSOLETE CENTRAL BOILER ROOM AND DETERIORATING TRANSMISSION LINES"

This well known chemical company had a sprawling plant with long transmission lines and condensation problems. Fluctuating steam needs throughout the plant made steam production a problem. The ordinary boiler had to be kept at full pressure all day... fired all night. Seven Clayton Generators stragetically located now provide just the right amount of steam—when and where needed. They are shut down at night. These seven Clayton generators installed cost less than the cost of new transmission lines.

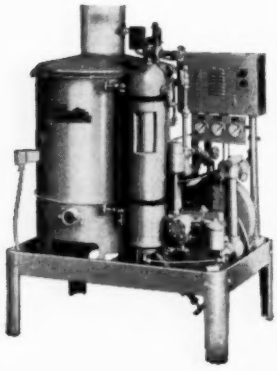


"OUR STEAM NEEDS FLUCTUATED CONTINUOUSLY. WE DIDN'T NEED COSTLY FULL TIME STEAM!"

This small metal working plant had a boiler that required a 24-hour fire and a man to watch it. Steam requirements fluctuated considerably wasting both fuel and steam. A Clayton replaced this obsolete boiler to produce only the right amount of steam when needed... automatically. Since it's fired only for the shift, fuel savings are considerable and a full time man is not required.

SOLVED THREE different STEAM PROBLEMS!

These actual case histories represent only a few of the reasons why smart business men buy Clayton Steam Generators. Basically the story is more steam at less cost in only one fourth the space occupied by ordinary steam boilers. They cost less to install too... no stacks to erect, no walls to knock out, lower rigging expense and lower hauling costs. The secret of Clayton's higher efficiency is *controlled circulation*—no space consuming straight tubes, but instead, a principle of using a coil without fired vessels... easier to operate and maintain. From a cold start, Claytons produce steam in 3 minutes. Let a Clayton representative give you the complete facts.



"IT WAS HOPELESS! WE NEEDED MORE STEAM AND WE DIDN'T HAVE ROOM FOR IT!"

Here was a well known beverage syrup company located in "midtown" squeezed in between buildings on all sides. To meet its additional steam needs, it went in only one direction ...up! Since a Clayton produces the same amount of steam in only one fourth the space and weighs only a fraction as much as an ordinary boiler, it was relatively simple to put two Clayton steam generators on the roof! The installation was quick and inexpensive.

EXCLUSIVE!

Compare Clayton's 5-year published coil warranty covering material and labor.

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aventi, a senior at Lehigh University; Cohen, a senior at Drexel Institute of Technology.

William H. Weed has become principal engineer at Solvay Process Division's research center at Syracuse, N. Y.

Octave J. DuTemple, associate chemical engineer, Argonne National Laboratory, Lemont, Ill., has been named executive secretary of the American Nuclear Society.

Paul Fannin of Phoenix, longtime leader in the bottled gas and chemical trades in Arizona, has announced his candidacy for the Republican nomination for governor.

W. R. Carlisle

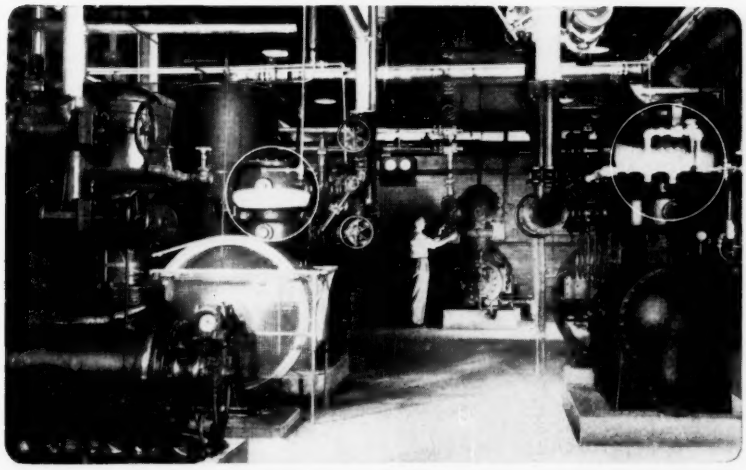
As of May 1, W. R. Carlisle has been associated with Falls Industries as sales engineer. He will handle the sales and service requirements for Falls Industries' complete line of impervious graphite processing equipment in Ohio, West Virginia and western Pennsylvania.

Carlisle earned his B.S. degree in chemical engineering from M.I.T. in 1939. Since his graduation, and before joining Falls Industries, he was associated with Du Pont, Allied Chemical Corp. and Foxboro Co. in engineering and sales capacities.

OBITUARIES

Hamilton Garnsey, Jr., 56, vice president and general manager of Goulds Pumps, Inc., Seneca Falls, N. Y., died April 26 after a brief illness.

LOOK AT THOSE FROSTED JACKETS

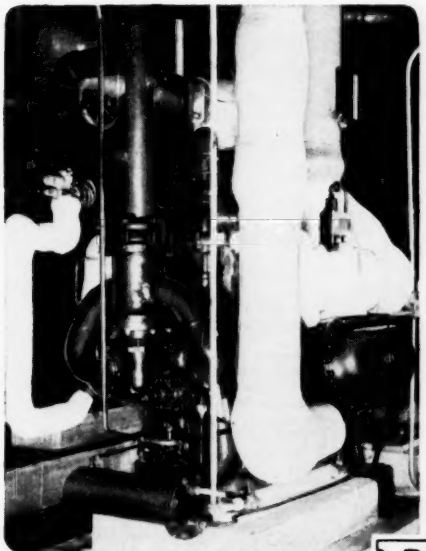


Two of five Frick booster compressors on a large low-temperature operation. All have cylinders cooled with direct-expansion ammonia. (Frick Patent No. 2,553,623)

They're a patented feature of Frick booster compressors . . . whereby the jackets are cooled with direct-expansion refrigerant.

These frosted jackets remove a tremendous amount of heat from the discharge of the compressor, and make the entire two-stage system operate with much higher efficiency.

Refrigerated jackets permit the cylinders to fill more completely, increasing the volume of gas pumped; they make the valves run cooler and causes lower compression temperatures. Better lubrication of valves and pistons results. The outlet connections from the jackets are carried to the suction of the second-stage machines.



Note the ammonia connections to cylinder jackets on this "ECLIPSE" booster, running at 1200 r.p.m., supplying low-temperature service.

Jackets cooled with refrigerant are much colder than those fed with water: also, the danger of freezing the water is avoided.

This highly efficient cooling system can be applied to staged refrigerating systems of any design, with any type compression equipment, using any refrigerant. It is protected by Frick Patent No. 2,553,623. The lower the temperature, the greater the savings—up to 20 per cent at minus 80 degrees. When you buy low-temperature refrigeration, insist on this important feature.

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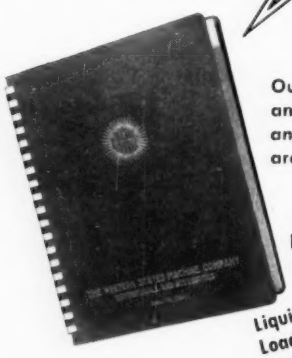

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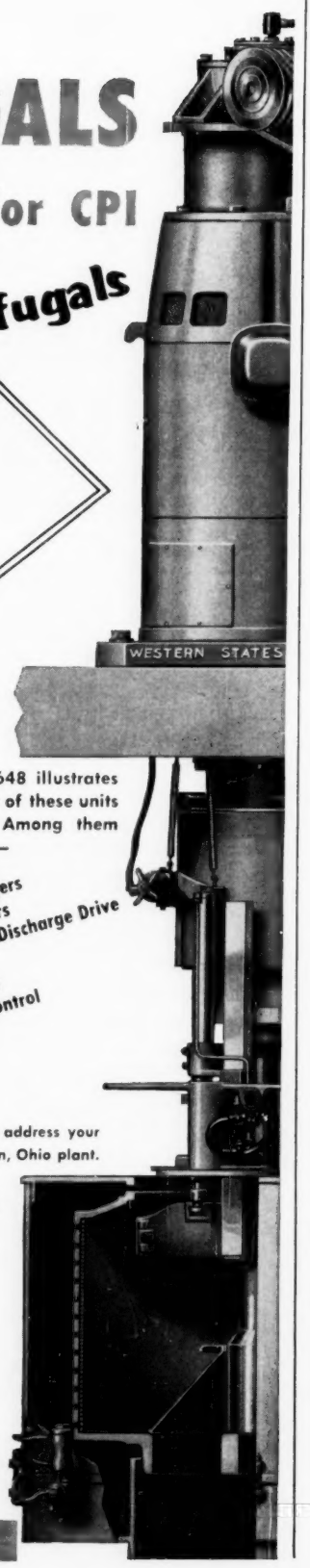

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Chemicals

Aluminum Hydroxy Chloride.....Astringen is registered brand name of complex form of aluminum hydroxy chloride. Widely used in antiperspirants, after-shave lotions. Product bulletin W101.
222A Waverly Chemical Co.

Anthracene.....Refined anthracene, available in 90-95% purity, undergoes many traditional reactions of organic chemistry. Raw material for Diels-Alder, Friedel Crafts reactions. Bulletin TDR-C574.
222B Barrett Div.

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204 *Quaker Oats Co.

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223A Norton Co.

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255 *Engelhard Industries.

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223B Prufcoat Laboratories.

Resins.....Specially treated Nuclear Grade Resins free of organic matter & inorganic materials found in ordinary ion-exchange resins. Exceptionally pure. Write for data sheet for full information.
L235 *Illinois Water Treatment Co.

Surfactants.....40 p. technical bulletin describes adducts of nonylphenol or tridecyl alcohol with ethylene oxide. These surfactants are marketed under trademark, Surfonic.
223C Jefferson Chemical Co.

Tantalum.....“Corrosionomics”, a journal of useful information for the solution of corrosion problems outlines, among many other articles, technical data on Tantalum, its uses & properties.
228 *Fansteel Metallurgical Corp.

Triethylborane.....is now being supplied in sample quantities for study as a catalyst for polymerization of unsaturated monomers, as a jet fuel or fuel component, & as an igniter. #1360.
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113-14p *U. S. I. Chem. Co.

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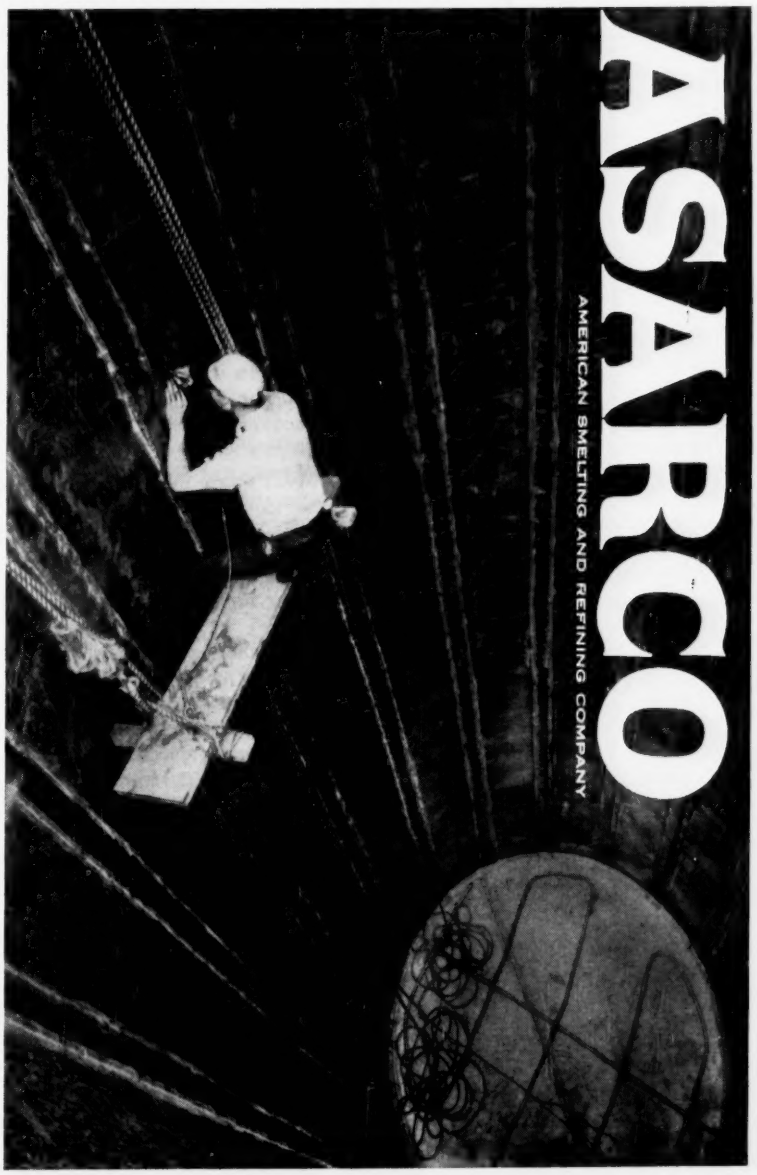

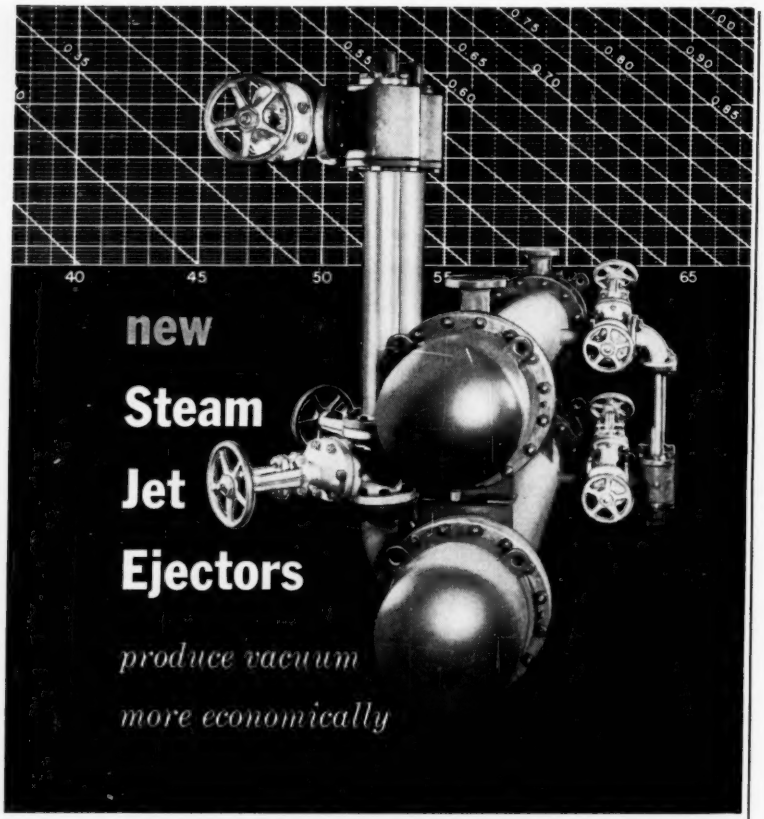

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224A Parmacel-LePage's Inc.

Adhesive Thermoplastic.....on dry, 100% solid, continuous cord-like form, is now being marketed with applicator especially designed for controlled feeding, melting & applying. Request #1362.
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244B Okonite Co.

Coatings, Protective.....6 p. bulletin describes Lithcote coatings and linings—durable baked-on phenolic, epoxy and other materials—for protection of industrial equipment against corrosion, contamination.
224C Lithcote Corp.

Coating Thermosetting.....corrosion-resistant for chemical plant floors is said to resist strong acids, alkalis & solvents, withstand temperatures of 230°F, support heavy traffic. #1364.
113-14k *U. S. I. Chem. Co.

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224D Automatic & Precision Mfg. Co.

Finishes, Fusion Bond.....4 p. folder describes line of Corvel cellulosic, nylon, polyethylene, K-51 (chlorinated polyether) and other new fusion bond finishes for use in cladding metal parts.
224E National Polymer Products.

Framework, Steel.....Three steps in planning, cutting and joining Bild-A-Flex steel framework are detailed in "Imagineering in Steel." Framework is used for low cost and quick construction.
224F Republic Steel Corp.

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223 *Federated Metals Div.

Linings, PVC.....Manual LC-58 covers three most useful types of polyvinyl chloride lining for corrosion protection. Includes information on new unplasticized PVC lining, Fligid.
224G Kaykor Industries.

(*Continued on p. 228*)

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Fansteel

Corrosionomics

REGISTERED U. S. PATENT OFFICE

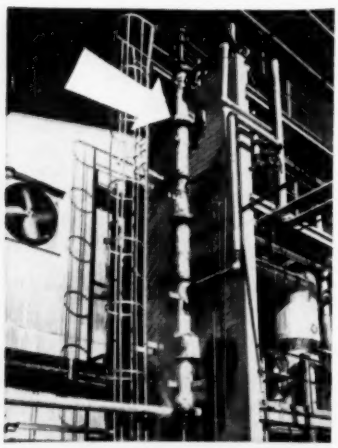
A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

TANTALUM HEAT EXCHANGER SOLVES HIGH TEMPERATURE HNO_3 PROBLEM

Commercial Solvent's plant at Sterlington, La., produces flake ammonium nitrate by neutralizing nitric acid with anhydrous ammonia. The reaction takes place at 400-460°F., driving off water introduced with the acid. A key piece of equipment in this operation is a Fansteel tantalum heat exchanger which has been giving outstanding service with no visible corrosion noted over a number of years.

Handles HNO_3 at 45 Gal/Min

This Fansteel equipment handles up to 45 gal/min at elevated temperatures with a heat transfer coefficient greater than 550 Btu/hr/sq ft/°F. It is made of three 8-ft. sections in series. If one unit must be removed the other two may be coupled and run at reduced flow. Each unit consists of a bundle of 19 straight tantalum tubes, ½" O.D. and with a 0.015" wall. This gives 20 square feet of heat transfer surface for each section.



Shown without lagging, three-section tantalum heat exchanger raises nitric acid temperature to 330°F.

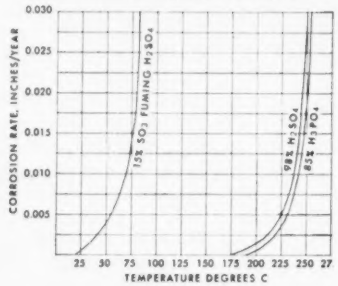
Corrosion Rate Nil in HNO_3

Montecatini, the huge Italian chemical company in Milan, exposed tantalum to 98% HNO_3 containing 0.1% H_2SO_4, 0.4% nitrogen oxides and 1.5% H_2O at 132°C for 762 hours. The corrosion rate was 0.00002 inches per year and the metal was unchanged in appearance. Tests by other companies confirm the low corrosion rates of HNO_3 in all concentrations even at elevated temperatures—as high as 200°C.

"U" Tube Bundles Also Available

Fansteel heat exchangers are also available with "U" tube bundles where processing or physical requirements call for a unit with input and output at the same end. No internal gaskets are used, which makes the leakage problem nonexistent. Teflon* grommets support each tube in the baffle holes and permit free movement, thereby eliminating the differential expansion problem.

Tantalum Also Resistant to Concentrated H_2SO_4 and H_3PO_4

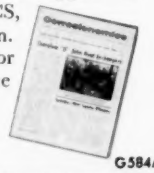


Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, if requested on your letterhead; contains both tantalum sheet and wire.

Free Technical Information

The above condensation is typical of the articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our free mailing list.



*Registered trade mark, E. I. duPont deNemours & Co., Inc.

For further data on the above, write:

G584A

FANSTEEL METALLURGICAL CORPORATION

CHEMICAL EQUIPMENT DIVISION

NORTH CHICAGO, ILLINOIS, U. S. A.

LITERATURE . . .

(*Continued from p. 224*)

Metal, Corrosive-Resistant.....Horton-clad is a corrosion-resistant composite metal of high-strength bonded clad material. Uniform thickness & adaptability of size & shape. Request Bulletin.
91 *Chicago Bridge & Iron.

Metal Products.....19 p. booklet covers Anaconda metal products, including copper, copper alloyed with other metals that can be manufactured commercially into sheets, plates, wire, rods, etc.
228A American Brass Co.

Packing, Column.....Made of embossed wire cloth, trimmed into flat conical discs. Bulletin gives the inside story on Stedman packing, its operating characteristics & test results.
228B Packed Column Corporation.

Electrical and Mechanical

Gaskets.....Bulletin AD-154 describes the complete line of spiral wound gaskets for high temperatures & pressures. Teflon jacketed gaskets for glass pipe flanges provide resilience & deformability.
14-15 *Garlock Packing Co.

Gaskets & Packings, Teflon.....request Bulletin T-104 for information on Chemlon line of better Teflon products. For formed gaskets, valve seats & packings, it pays to inquire about Teflon.
213 *Crane Packing Co.

Manifolds, Gas....."Manifolds for Gases," catalog 829, contains specific information regarding cylinder arrangements, dimensions, general background information on advantages of manifolding.
228C Air Reduction Sales Co.

Motor Circuit Protection.....Bulletin 5040-A covers fundamentals of selective short-circuit protection for motor circuits. Reviews features, applications of type ETI molded-case circuit breaker.
228D I-T-E Circuit Breaker Co.

Motor, Immersible.....built to operate in water, sewage, or liquid chemicals. Motor is oil-filled & sealed, diaphragm breathers equalize pressure at shaft seal & prevent leakage. Bulletin 2300.
116 *Louis Allis Co.

Rectifier Equipment.....custom engineered rectification in Semiconductor Power Conversion Equipment & Systems. Flexible modifying designs to meet specific needs. Send for Free "Guide".
BL245 *Sel-Rex Corp.

Switch, Mercury.....Data Sheet 144 describes nylon-enclosed mercury switch made of materials which are highly resistant to water, oil, alkalis, acids. Synthetic rubber embedment protects unit from shock.
228E Micro Switch Co.

Transformers, Variable.....Powerstat variable transformers which deliver a continuously adjustable voltage from a.c. power are available in dust-tight enclosures. Data Sheet SE-L2581.
228F Superior Electric Co.

* From advertisement, this issue

Handling & Packaging

Bag Closer.....Model CR portable bag closer, driven by non-electric air motor, is designed for use under hazardous conditions such as gaseous and explosive atmospheres or when using flammable materials.
R243 *Dave Fischbein Co.

Conveyor Components.....Recently introduced screw conveyor components reduce power demands and maintenance delays. They include conveyor screws, hangers, trough end seals, etc. Folder 2489.
47 *Link-Belt Co.

Drums.....Two pamphlets describe specifications of new drums. One reviews advantages of 55-gal. tight head Uni-Drums which interlock. Other explains uses, describes accessories for various drums.
229A Vulcan Containers Inc.

Feeders.....all Hardinge feeders from 100 pounds/hour to 100 tons/hour are suspended from the feed bin which eliminates costly feeder support structure & provides accessibility to equipment. #33E11.
230 *Hardinge Co.

Feeders, Airlock.....Booklet P-55, "How to Select a Rotary Airlock Feeder", describes airlocks for low pressure dust control and high pressure pneumatic conveying. Standard, heavy duty, blow-thru.
BL241 *Prater Pulverizer Co.

Lifter-Dumper.....In one continuous movement, skip-hoist Vertical-Dumper can lift 2,500 pounds to any practical height, and dump the load at a prescribed angle of 45 degrees.
229B Essex Conveyors.

Materials Control.....How Selecto-O-Weigh system provides complete automation in continuous or batch processing operations, including record keeping, is discussed in Bulletin 0557.
229C Richardson Scale Co.

Rack, Barrel.....How modern materials handling techniques can be applied to steel drums for the first time by use of newly developed portable steel barrel racks is described in Bulletin 961.
229D Republic Steel Corp.

Scales.....Today weighing is a vital element in your overall cost control system. New Toledo Weight Fact Kit will help you determine how well your scales measure up as a weighing system.
30 *Toledo Scale Div.

Tanks, Plastic.....Series of data sheets describe advantages of corrosion-resistant plastic tanks, vents, ducts, hods, pipes, fittings and various items of pilot-plant equipment. Send for your copy.
229E Carl N. Beetle Plastics Corp.

Weigher, Belt (Stream).....Bulletin describes Pneu-Weight continuous weighing scale; lists advantages of unit; describes simple operation and available accessories; contains drawings. Bulletin 36-P1.
229F Omega Machine Co.

* From advertisement, this issue

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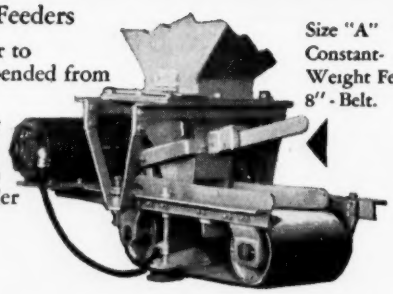

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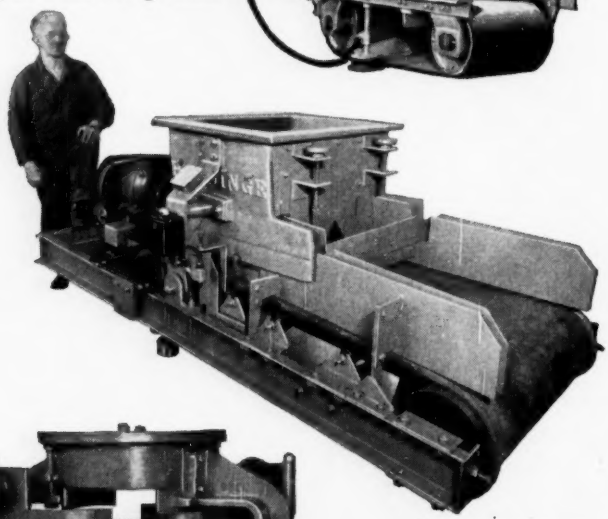

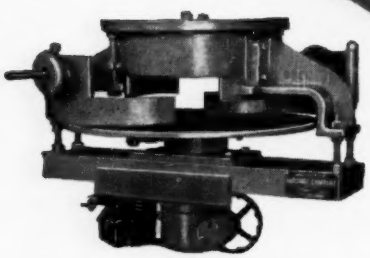

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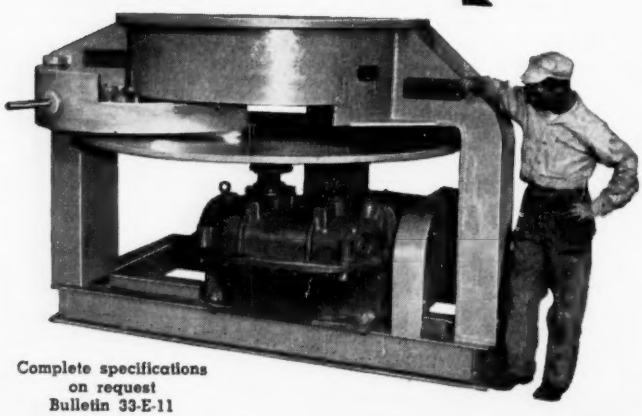
84" Disc Feeder



Complete specifications on request
Bulletin 33-E-11

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118 *Autoclave Engineers, Inc.

Boilers.....“Forty Facts You Should Know About Kewanee Boilers” covers general characteristics of entire line of Kewanee boilers, both high and low pressure—both firebox and scotch type.
230A American-Standard.

Burner, Vortex.....Here is a versatile unit that gives rapid, clean combustion on a wide range of fuels including Bunker C, No. 6, light oil, any gas. Standard models available. Write for Bul. #111.
234 *Thermal Research & Engineering.

Cold Storage.....Manual on vermiculite for low-temperature insulation gives information on vermiculite refrigeration fill, insulating concrete mixes, asphalt-bound vermiculite for cold storage floors.
230B Zonolite Co.

Ejectors, Steam Jet.....available in single & multiple stages & in a wide range of sizes & materials. New 8-page bulletin describes corrosion-proof design, & contains Dalton's Law Charts.
224 *Southwestern Engineering Co.

Heaters-Coolers.....Bulletin 135 on air engineering for process industries describes after-coolers, air conditioners, liquid coolers, heat exchangers, condensers, refrigeration equipment.
TL253 *Niagara Blower Co.

Heaters, water.....equipped with Booster pump that increases the capacity of the boiler. Instantaneous heating with full temperature controls. Send for booklet describing full line of heaters.
45 *Bell & Gosset Co.

Heat Exchanger.....Readily assembled to handle any combination of liquids & gases, can be used as a heater, cooler, condenser or vaporizer. Extreme flexibility predominates. Bulletin 302.5K1.
37 *American-Standard.

Heat Exchangers.....Company offers Bulletin 707, on condensers, brine coolers and heat exchangers, and Bulletin 427, on industrial heat exchangers. They make four basic types of exchangers.
238 *Vilter Mfg. Co.

Heat Exchangers.....8 p. bulletin describes inherent benefits of plate heat exchangers. List of applications, complete dimensions, mechanical specifications and features are given.
230C De Laval Separator Co.

Heat Transfer Equipment.....Platecoil units are compact & lightweight, require about ½ the space of pipe coils. Available in Stainless, cold Rolled Steel & other corrosion-resistant alloys. Manual P61.
98 *Platecoil Div. Tranter Man.

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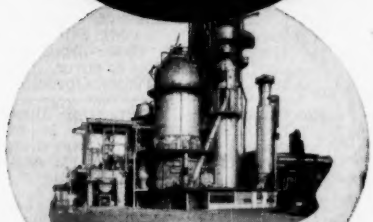

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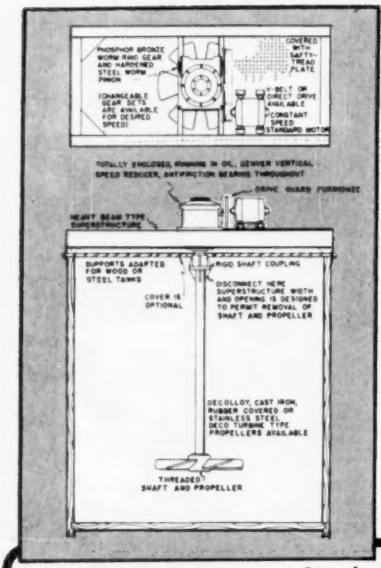

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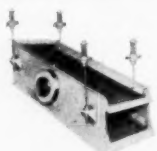

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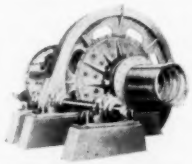

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115 *Air Preheater Corp.

Tandem Units.....exclusively for vertical firing, these new oil-gas combustion units retain all the features of our horizontal tandems. Many more hours on steam, without shutdown. Bulletin 498.
R239 *National Airoil Burner Co.

Thermo-Panels.....instead of obsolete & costly pipe coils, up-to-date engineers are now using Dean Thermo-Panels. Bulletin #355 gives technical data. Bulletin #258 covers price estimations.
TL239 *Dean Thermo-Panel Coil Div.

Instruments & Controls

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232A Cambridge Instrument Co.

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232B Beckman/Scientific Instruments.

Control Systems.....Choose the indicating controller ideally suited to your processing needs. Get the facts on their proved performance requiring indicating & controlling of temperatures, etc., in Bul. F6314.
229 *Barber-Coleman Co.

Controls, Temperature.....A new 8-page catalog furnishes specifications and descriptive data on a wide variety of general-purpose, dual-switch, and explosion-proof temperature controls. Cat. 400.
232C United Electric Controls.

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18-9 *Fisher Governor Co.

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Gage, Liquid Level.....Instant remote reading, amazing accuracy, now available with a unique new safety feature, an illuminated scale that flashes red if boiler water level is too high or too low. Bulletin.
L237 *Jurguson Gage & Valve Co.

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232E American Air Liquide.

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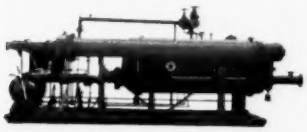

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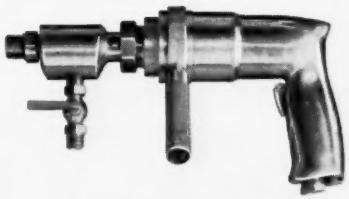

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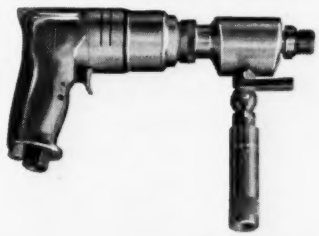

ELLIOTT 512300
Heat Exchanger Tube Cleaner
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16-4a

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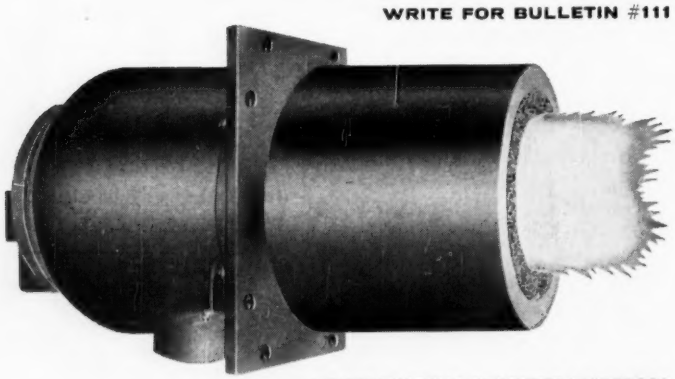

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113-14o *U. S. I. Chem Co.

Measuring Instrument, Optical..... Scan-A-Scales are precision instruments which provide longitudinal, crosswise or vertical settings to ten thousandths of an inch. Used to increase production, cut costs.
234A F. T. Griswold Mfg. Co.

Thermometers.....Catalog C60-2 describes complete line of rectangular case, filled system thermometers. These indicators, recorders, transmitters are covered in detail in 56 p. catalog.
234B Minneapolis-Honeywell.

Television, Industrial....."How Many Jobs," 8p. brochure, covers complete line of industrial television equipment including cameras, control units, monitors, accessories, projection systems.
234C General Precision Laboratory.

Pipe, Fittings, Valves

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Nozzles.....lightweight, precision-built steel spray nozzles. Feed just the right amounts of fuel into combustion chamber. Get complete spray nozzle catalog-absolutely free.
210 *Spray Engineering Co.

Pipe & Tubing.....send for a copy of the new Trent 48-page handbook for complete information on stainless & high alloy welded pipe & tubing. Features high strength & uniformity.
97 *Trent Tube Co.

Pipe, Jacketed Plastic.....Jal-Jacket, rigid plastic pipe encased in a steel jacket, combines pressure-retaining strength of steel pipe with chemical resistance of unplasticized polyvinyl chloride pipe.
234E Jones & Laughlin Steel Corp.

Pipe, Plastic-Coated.....Adv. 770-R is revised 4 p. folder on X-Tru-Coat plastic-coated steel pipe and tubing. Recent improvements in pipe, now yellow for high heat reflectivity, are covered in folder.
234F Republic Steel Corp.

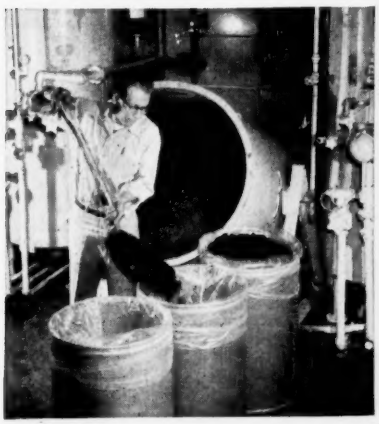
Pipe, Pyrex.....keep out traces of distilled organic impurities that sneaks in through absorption & scrubbing towers, by using Pyrex Pipe. Bul. PE-3 shows how this glass pipe helps end corrosion.
250 *Corning Glass Works.

Pumps, High Vacuum.....Bulletin #400A describes the KMB pumps that have proven themselves in the most difficult applications. From vacuum ranges of millimeters to microns, they are efficient & economical.
207 *Kinney Mfg. Div.

* From advertisement, this issue

ILLCO-WAY ionXchange

PACKING
SPECIAL RESIN
AT ILLCO PLANT



NUCLEAR GRADE
EXCEPTIONALLY PURE
SUPER-REGENERATED

RESINS

ILLCO Nuclear Grade Resins are specially treated to remove the organic matter and inorganic materials which are found in ordinary ion-exchange resins, after which treatment they are super-regenerated on any selected cycle. Nuclear Grade Resins are suitable for research and process applications where higher-than-ordinary purity of the resin is required. Nine standardized types are available, and special types can be produced on request.

USED AT SHIPPINGPORT

ILLCO Nuclear Grade Resins are used to purify water used for heat transfer and shielding at the great new pioneering atomic energy power plant at Shippingport, Pa., a joint project of the Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

WRITE FOR THIS DATA SHEET

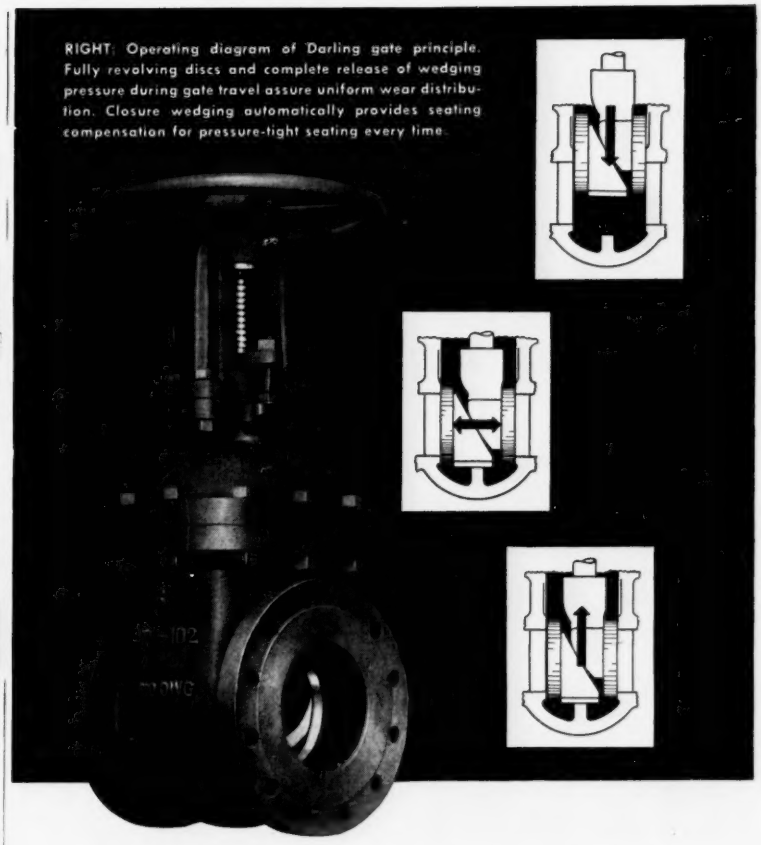
Gives information on all types of Technical and Nuclear Grade Resins, together with clear illustrations of important ILLCO color indicator.

ILLCO-WAY

ILLINOIS WATER TREATMENT CO.
840 Cedar St.
Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

RIGHT: Operating diagram of Darling gate principle. Fully revolving discs and complete release of wedging pressure during gate travel assure uniform wear distribution. Closure wedging automatically provides seating compensation for pressure-tight seating every time.



How Darling gate valves can help

MAINTAIN PROCESS SCHEDULES

THE unique Darling gate valve principle, diagrammed above, provides today's best assurance of prolonged good behavior and avoidance of leaks and process interruptions! It's a natural where the most reliable operation is vital month in, month out.

You'll find this feature in Darling's economical hard-rubber-lined iron body valves for corrosion services up to 150 pounds. Same goes for other Darling gate valves in sizes, types and metals of various alloys for all kinds of normal and unusual services. Write for Catalog No. 57.

ENGINEERING SERVICE: Darling offers unusual facilities for the development and manufacture of special valves for out-of-the-ordinary requirements. This special service is available to you at all times, without obligation.

DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.
Manufactured in Canada by
Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

DARLING VALVES

Designed with the Look of Tomorrow by Raymond Loewy Associates

NEW PARTLOW MFS TEMPERATURE CONTROL

New Looks, Convenience, Efficiency for Your Process Equipment

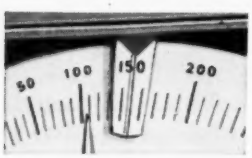
Striking as they are, good looks are only part of the story of Partlow's spectacular new control. Inside and out, the MFS is as rugged and efficient as a temperature control can be, its tough mercury-actuated element having been built to retain sensitivity and accuracy even under extreme conditions. Convenient, too! You can interchange the mercury element right out in the field... no factory adjustment is required.

The MFS comes in 10 scale ranges. Accurate within ½ of 1% of scale range, it is especially adaptable to control applications where temperature variations must be kept at a minimum; or where sudden temperature changes demand instant response.

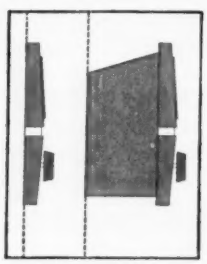
If your product or process requires close, positive temperature control within the –30° F. to 1100° F. range, you are invited to test this advanced new instrument soon. Write, wire or phone today.

THE PARTLOW CORP.
DEPT. E-658 NEW HARTFORD, N.Y.

Only in the Partlow MFS so many important innovations:



Accu-Vision Dial — Magnified pointer for closest settings. Dial calibrations, pointers and background scientifically color-contrasted for easy readability — even at a distance.



Flush or Wall Mounting — No additional brackets or hardware are required. Case is grey reinforced plastic —tough, lightweight, easy to clean, won't crack under extreme temperatures.

LOOK TO PARTLOW FOR:
Recording Controls Indicating Controls
Non-indicating Electrical Controls
Non-indicating Mechanical Controls Timers
Recording and Indicating Thermometers
Limit Controls Combustion Safeguards

PARTLOW

LITERATURE . . .

Tubing, Flexible Metal.....Large diameter flexible metal connectors in stainless steel & other alloys to handle expansion & contraction, wide range of temperatures, corrosive fluids, etc. Catalog.
110 *American Brass Co.

Valves, Feeder.....High-pressure rotary feeder valves are designed for positive, accurate feeding into pressure vessels, with a minimum of steam or temperature loss. Bulletin 197.
236A Sprout, Waldron & Co.

Valves, gate.....Exceptional performance. Longer valve life, less maintenance, easier operation. Made in various alloys, types and sizes for most services. Send for complete information in Catalog 57.
R235 *Darling Valve & Mfg. Co.

Valve, Reducing.....Design features of DBI pressure reducing valve are described in Bulletin 1051. Also explained are mechanical details of this direct-operated valve with specs giving pressure ratings.
236B Copes-Vulcan Div.

Process Equipment

Agitators & Mixers.....Patented standpipe around propeller shaft of agitators and mixers assures positive agitation and circulation. Heavy duty and acid-proof construction. Bulletin A2-B4.
232 *Denver Equipment Co.

Agitator, Continuous.....Nettco Flomix is the ideal solution for combining two or more liquids, or solids & liquids flowing through your pipelines . . . in mixing, blending, bleaching. Bulletin #531.
R237
*New England Tank & Tower Co.

Blenders.....Sturtevant rotary blenders start 4-way blending while charging. continue it during discharge, thus producing highly intimate, even blends of dry and semi-dry materials. Write for Bul.080B.
R245 *Sturtevant Mill Co.

Centrifugals.....For trouble-free performance & excellent quality of centrifuge product, write for your complementary copy of Bulletin 356. Complete line of centrifuges that perform from every angle.
TL241 *Heyl & Patterson.

Centrifugals.....the safest you can buy—because of reverse plowing, overload protection, thermal control built-in, curbing & smooth braking. Data #2648.
222 Western States Machine Co.

Centrifuges.....four-page brochure on De Laval line of cenrifuges for the process industries gives specifications. High-capacity centrifuges offer savings in manpower & space.
59 *De Laval Separator Co.

Dust Collection Systems.....Only Buell Cyclones have the "Shave-Off" that removes the fines carried in the double-eddy currents, minimizes reentrainment, assures measurably higher efficiency. Booklet
90 *Buell Engineering Co.

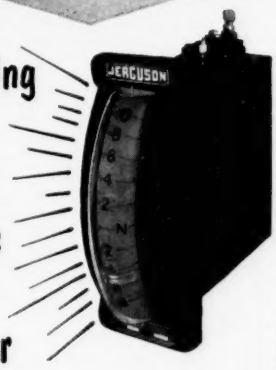
*From advertisement, this issue

Here's Jerguson's

New!

RED FLASHER TRUSCALE

Remote Reading Liquid Level Gage



Flashing Red Scale Warns of Danger

Jerguson Truscales are now available with a unique new safety feature. Illuminated scale starts flashing red if boiler water level gets too high or too low. This positive warning flashes continuously until the dangerous condition is corrected.

Truscales offer the greatest possible protection for expensive equipment. They give instant remote reading of liquid level of boilers, tanks, etc., with the amazing accuracy of ½ of 1% of scale reading. Convex face, with scale markings directly on it, gives 180° visibility. It's easy to take readings from any point from which the face can be seen.

Protect valuable equipment with Jerguson Truscale Remote Reading Gages. Send for new 8-page bulletin which gives complete details.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

UNIQUE! VERSATILE!

continuous in-line agitator...

mixes your flows on the go!

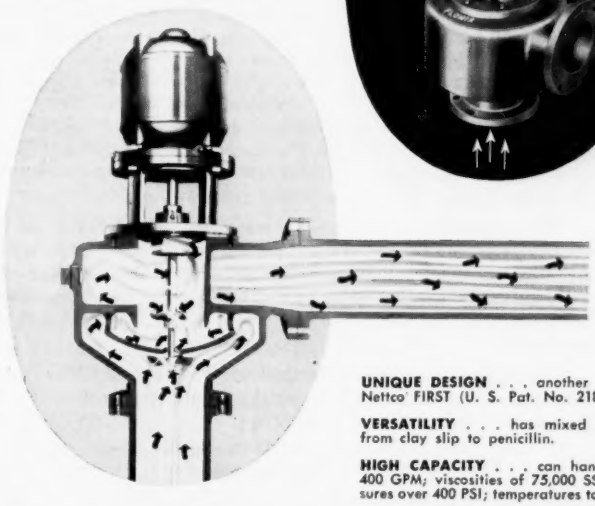
For profitable processing, investigate

NETTCO FLOMIX®!

Would your operation benefit from

- **fast, uninterrupted processing?**
- **greater product uniformity?**
- **simplified piping arrangements?**
- **elimination of intermediate storage tanks and/or mixing vessels?**
- **reduced maintenance?**

Nettco Flomix is the ideal solution for combining two or more liquids, or liquids and solids flowing through your pipelines . . . in mixing, blending, reacting, washing, contacting, bleaching, absorbing, chlorinating, clarifying, or similar processes.



UNIQUE DESIGN . . . another patented Nettco FIRST (U. S. Pat. No. 2183859).

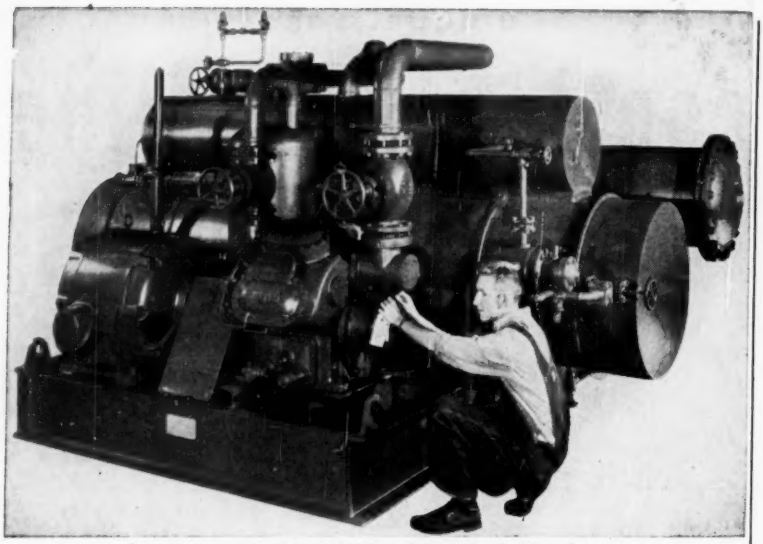
VERSATILITY . . . has mixed solutions from clay slip to penicillin.

HIGH CAPACITY . . . can handle over 400 GPM; viscosities of 75,000 SSU; pressures over 400 PSI; temperatures to 300° C.

Let Nettco agitation engineers show you how the Flomix can make your continuous processing more profitable. *Request* Bulletin No. 531. *Write* to **New England Tank & Tower Co., 87 Tileston Street, Everett 49, Massachusetts.**

NETTCO

ENGINEERED AGITATION SPECIALISTS



Shown is one of two identical Vilter ethylene glycol chillers factory assembled as a packaged unit for a large chemical company.

NOW, large-size, "packaged"

VILTER

HEAT EXCHANGERS

to meet your exact specifications

The above ethylene glycol chiller built for a large chemical company is factory assembled as a packaged unit. The principal Vilter components include: an 8-cylinder VMC ammonia compressor, 24" x 14' ammonia condenser, 12" x 12' liquid ammonia receiver, 30" x 12' flooded ethylene glycol chiller capable of cooling 405 gpm of 30% ethylene glycol solution from 25°F. to 20°F. The chiller has a 16" surge drum integrally welded to it. All electrical equipment is installed in explosion proof enclosures. It is typical of the custom work Vilter is doing in the field of heat exchangers and pressure vessels to meet design and budget requirements.

Vilter makes all four basic types of heat exchangers: shell and coil, shell and tube, shell and tube bundle, and atmospheric . . . and in every possible modification. Vilter can give you the most efficient heat exchange equipment with working pressures as high as 10,000 psi. Vilter is equipped to build vessels in conformance to both the A.S.M.E. Code and T.E.M.A. standards.

Today, more than ever before, the leading names in both the chemical and petroleum industries are turning to Vilter for their special vessel needs. Consult with Vilter about your needs.

Write for these helpful bulletins to The Vilter Manufacturing Company
Dept. K-718, 2217 S. First Street, Milwaukee 7, Wisconsin

Bulletin 707
Vilter Condensers
Brine Coolers
Heat Exchangers

Bulletin 427
Vilter Industrial
Heat Exchangers

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REFRIGERATION and AIR CONDITIONING

THE VILTER MANUFACTURING COMPANY, Milwaukee 7, Wisconsin

Air Units • Ammonia & Freon Compressors • Booster Compressors • Baudelot Coolers • Water & Brine Coolers • Blast Freezers • Evaporative & Shell & Tube Condensers • Pipe Coils • Valves & Fittings • Pakice & Polarflake Ice Machines

LITERATURE . . .

Dust Collector.....Hydro-Filter has no moving parts within dust collection area, is self-cleaning on round-the-clock basis, is effective through variation in volume and velocity of flow. Bulletin 55.
238A National Dust Collector Corp.

Dust Collector.....Pangborn Ventrijet Wet Dust Collector uses exclusive venturi tubes for peak efficiency. Simplicity of design saves money in its ease of installation, low cost of operation. Bulletin 922.
130 *Pangborn Corp.

Dust Collectors.....Ducon centrifugal wash collector, Type UW-4, is a basic air scrubber with applications for the wet principle collection of problem dusts & recovery fines. Bul. W-7456.
211 *Ducon Co.

Electrolytic Polishing.....Hypalon outlasts other materials 8 to 1, is resistant to strong oxidizing chemicals, is ozone-proof & performs well in temperatures up to 350°F. Booklet offered.
109
*E. I. du Pont de Nemours & Co.

Equipment.....for radio-active operations is described in a new book now being sold. The volume contains some 60-odd papers delivered as part of the 1957 Nuclear Congress. Book #1361.
113-14h *U. S. I. Chem. Co.

Feed Systems, Odorant.....Application Engineering Data Sheet E-58-2 illustrates and describes four modern, automatic methods to meter and feed a precise ratio of odorant to natural gas lines.
238B Milton Roy Co.

Filters.....save two ways with new hi-capacity filters through improved production & decreased downtime. Sturdy steel filters available in a full range of sizes. Write for free folder now.
32 *Commercial Filters Corp.

Filter Cloth.....Wedge-shaped openings allow only the filtrate to pass through. Reversible, both sides identical. Available in variety of weaves, in all malleable metals. Send for new catalog E.
219 *Newark Wire Cloth Co.

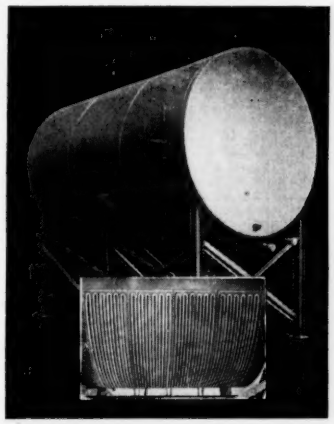
Filter Media, Porous Metal.....Fused seams, controlled partical size, greater surface area and thin walls for decreased differential pressures are the features of this efficient media. Booklets available.
136 *Purolator Products, Inc.

Filters, Pressure Leaf.....Right in price & right in specifications. Complete line of filters for large volume clarification & for quick cake discharge. Send for your free copy of Bulletin 146.
R217 *T. Shriver & Co.

Generators, inert gas.....Kemp inert gas generators with the famous industrial carburetor. Precise control of inert gas quality. Better quality control and increased safety. Write for Bul. I-10.
46 C. M. Kemp Mfg. Co.

Heat Treating.....Technically informative Catalog on heat treating processes and processing equipment covers protective atmosphere annealing, brazing and hardening of metals in different type furnaces.
238C Ferrotherm Co.

* From advertisement, this issue



This **TANK** is **HEATED** without **PIPE COILS**

The photo in the foreground shows how the modern

DEAN. THERMO-PANEL COIL

is CURVED to accurately fit the round tank. In the "old days" tanks of this kind were heated by old-style pipe coils installed INSIDE. The Dean Thermo-Panel Coil which TAKES THE PLACE of pipe coils is much more efficient and economical.

Bulletin 355—52 pages—tells all about it. Bulletin 258 gives Prices and Design data. With their aid many Chemical Engineers now do their own estimating and designing.

Backed by 20 Years of Panel Coil Manufacturing.

DEAN THERMO-PANEL COIL DIVISION
DEAN PRODUCTS, INC. 612 Franklin Ave
BROOKLYN 38, N. Y. Tel. Sterling 9-3400

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HAS MORE ENGINEERS ON ITS PUBLISHING STAFF THAN ALL OTHER CHEMICAL PROCESS INDUSTRIES TECHNICAL PUBLICATIONS PUT TOGETHER

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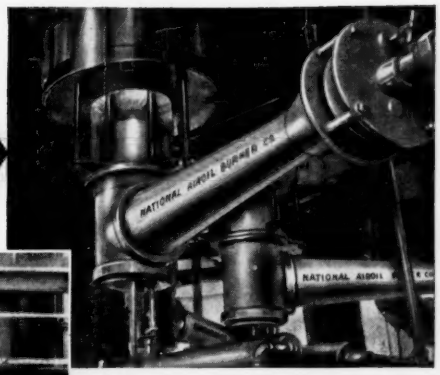
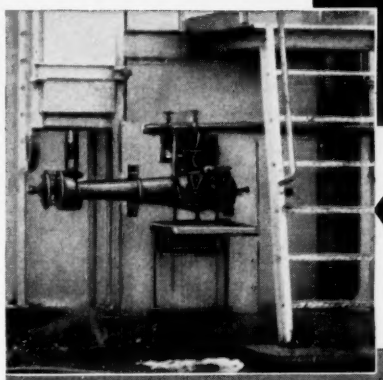
Published every other monday for Chemical Engineers in all functions

VERTICAL





OR HORIZONTAL

many more hours on stream with

NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

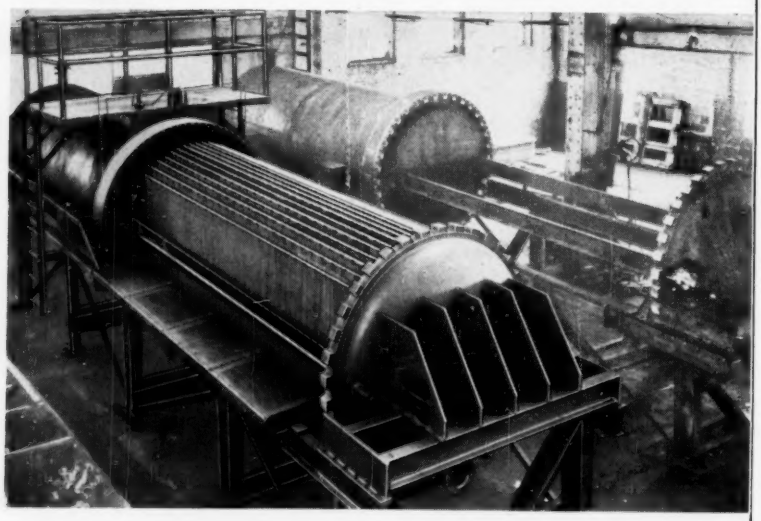
The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNIT's clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

National Airoil BURNER COMPANY, INC.

Main Office & Factory: 1234 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS



G-B Retractable Shell-Type Filter Clarifies green Sodium Aluminate Liquor

This new filter, the retractable shell, is designed for filtering under pressure. Originally developed for the aluminum industry, this unit has proved to be extremely successful for clarifying green sodium aluminate liquor. Perhaps the most unique feature is the fact that filtrate lines need never be broken, but are permanently connected to achieve high pressure filtration without leakage. The retractable shell filter is available now for all types of process problems. Pressures up to 100 psig, sizes to 3000 sq. ft. Generally constructed of steel; however, it can be built from stainless steel and other specified metals.

Write for more complete information.

GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
BIRMINGHAM, ALABAMA

FILTERS • EVAPORATORS
PROCESS EQUIPMENT
CONTRACT MANUFACTURING
including HEAVY CASTINGS

Homogenizers.....Emulsions & dispersions are broken up to extremely small size achieving a maximum degree of uniformity & stability. For a better product at lower cost, get a set of GTA bulletins.
242 *Manton-Gaulin Mfg.

Laboratory Ware, Plastic.....chemically resistant polypropylene lab equipment now available. PVC transparent tubing, tube fittings & recovery traps in assorted plastics. Write for Catalog #G358.
240A The Nalge Co., Inc.

Mills.....30 p. catalog offers latest information and changes in line of semi-fine and fine pulverizing screen and pneumatic roller mills. Contains drawings, specs, capacity facts. Catalog 63.
240B Bradley Pulverizer Co.

Mill, Compacting.....precise control of particle size, density & solubility factors assured with A-C compacting process. The heart of this completely mechanical system is the mill. Bul. 07B8836.
131 *Allis-Chalmers.

Mills, grinding.....Complete line of rod, ball, tube, pebble and compartment grinding mills to meet specified conditions for wet or dry grinding in practically any process. Bul. 232.
41 *Nordberg Mfg. Co.

Mixers.....Mix-Mullers give positive moisture control, intensive blending and controlled dispersion. They can be used to prepare any dry or wetted solid. Send for Bulletin on CPI uses.
138 *National Engrg. Co.

Mixers, portable.....Especially designed for small batch processes. Precise mixing results with long term cost savings. Eastern's improved line is included in the revised portable bul. 530.
206 *Eastern Industries, Inc.

Mixing & Agglomeration Equipment.....Extrusion machines with single speed or variable speed motors. Agglomeration equipment reduces dusting losses. Request literature by specifying Bulletin #'s in ad.
251 *International Eng. Inc.

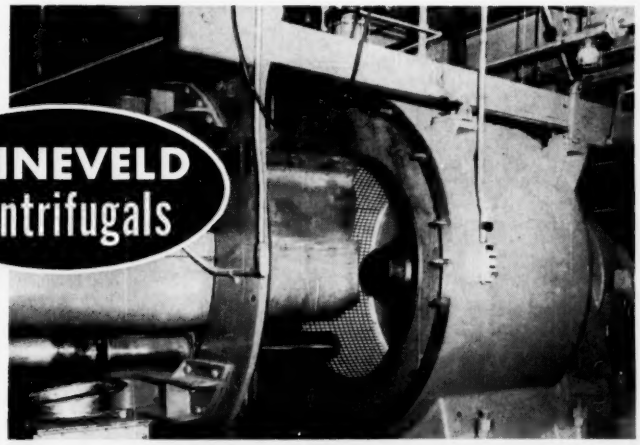
Screen, Vibratory.....14 p. catalog lists complete data and specifications on Syntron pulsating-magnet screens, concentric-action screens, unbalanced-pulley screens, Grizzly Bar screens, screening feeders.
240C Syntron Co.

Sifters.....Super active ball cleaning device provides rebound points in each ball compartment, assuring fast, thorough sifting of your product. Stabilizer maintains screen in position. Free brochure.
203 J. H. Day Co.

Pumps, Blowers, Compressors

Compressors.....Built on the Clark originated balanced/opposed principle, provide maximum power on less fuel in minimum space. Wide range of applications attest to their high efficiency. Catalog.
125 *Clark Bros. Co.

* From advertisement, this issue



REINEVELD centrifugals

This 68″ Automatic Reineveld Centrifuge, recently installed at Corn Products Refining Co., Argo, Ill., produces 1 ton of cornstarch powder every 7½ minutes. It dries a 22° Baume Slurry to an average moisture of only 34%. The higher G-forces, possible with a Reineveld Centrifuge, result in drier products and higher tonnages.

Consult our listing in CEC or write for bulletin 356.

Sold and Serviced by:

Heyl & Patterson INC.

55 FORT PITT BLVD. · PITTSBURGH 22, PA.

PRATER CAN Solve YOUR AIRLOCK FEEDER PROBLEM!

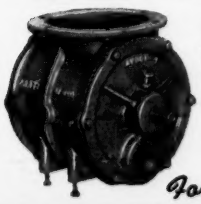
More than 2000 different Prater Airlock applications have solved processing requirements for 300 concerns. You'll find there IS a Prater Airlock for your need . . . from low pressure dust control to high pressure pneumatic conveying.

STANDARD DUTY

Principally adapted for sealing off collectors against air leakage.
Four Sizes . . . 6″, 8″, 10″ and 12″.

HEAVY DUTY

For applications involving high pressure Pneumatic Conveying or Volumetric feeding of finely ground materials.
Four Sizes . . . 6″, 8″, 10″ and 12″.



BLOW-THRU

For pneumatic conveying systems handling flour or similar fine powder or granular material.
Available for 2″, 3″ or 4″ Conveying Lines.

Send for informative Booklet P-55
"How to Select a Rotary Airlock Feeder"

Foremost Builder of Rotary Airlock Feeders

PRATER PULVERIZER COMPANY
1517 SOUTH 55TH COURT · CHICAGO 50, ILLINOIS

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for truly AUTOMATED SPEED CONTROL

Where automation performance depends on accurate speed control.

Get mechanical drive accuracy and range with electrical control flexibility at lower cost.

Graham

most reliable variable speed drive made

Greater accuracy of speed setting and holding on open loop control — wider range and faster response for closed loop systems.

CONTROL SPEED in ADJUSTABLE PROPORTION to:

1. POTENTIOMETER SETTING or RECORDER SLIDEWIRE
2. .5 to 5 ma or any TRANSDUCER SIGNAL
3. 3 to 15 PSI AIR SIGNAL
4. PARALLEL BINARY SIGNAL from PUNCH CARDS, TAPES, COMPUTERS or BINARY TRANSDUCERS
5. VARIABLE FREQUENCY SIGNAL

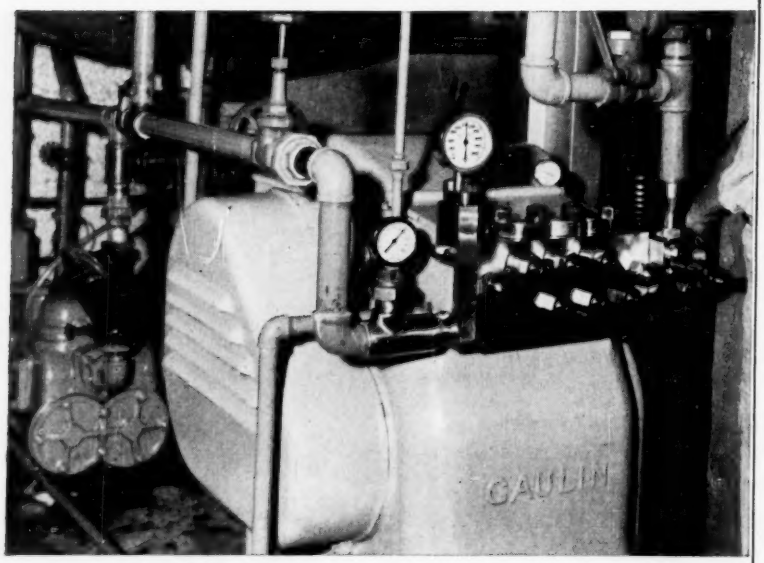
- **UNLIMITED SPEED RANGE**
- **UNMATCHED ACCURACY**
- **ULTIMATE SIMPLICITY and COMPACTNESS**
- **NO BELTS OR TUBES**
- **LOW COST**

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

ENTIRE UNIT EXPLOSION PROOF, if desired.

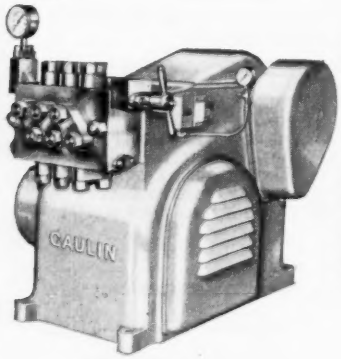
GRAHAM TRANSMISSIONS, INC.
Dept. CE, Menomonee Falls, Wis.

HOMOGENIZING and SUB-MICRON DISPERSION FOR EXTREME PARTICLE BREAK-UP



The new dimension in processing is GTA† and Gaulin Particle Control. It provides the means to reduce ingredients in your product to ultimate particle size — yielding vastly superior dispersions and emulsions.

Gaulin Homogenizers work at high pressures, and by means of tremendous velocity and energy gradients create zones of extreme concentrated turbulence. Result: Emulsions and dispersions are broken up to extremely small size achieving a maximum degree of uniformity and stability.



Sub-Micron Disperser is designed to provide these same advantages for pigments and other abrasive dispersions. S-M-D valve uses same principle as Homogenizer valve to produce dispersions of ultimate fineness.

Try GTA† and Particle Control. Gaulin Technical Assistance — GTA — will provide technical data and laboratory analysis to help you disperse, emulsify and blend by the most effective method . . . for a better product at lower cost.

†Gaulin Technical Assistance

Write for your set of GTA Bulletins

Gaulin TRADE MARK
MANTON Gaulin
MANUFACTURING CO. INC. EVERETT, MASS.

Manton-Gaulin Manufacturing Co., Inc.
71 Garden Street, Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, positive displacement, pressure exchange pumps, dispersers, homogenizers and colloid mills.

LITERATURE . . .

Compressor, Air.....Guard your product quality with low-cost, oil-free air assured by the CRX carbon piston air compressor. Pistons, piston rings & rod packing made of self-lubricating carbon. Bul. CRC-10.
31 *Gardner-Denver Co.

Compressors, Centrifugal.....64 p. catalog includes introduction to centrifugal compressor features, applications; sections on horizontally and vertically split compressors; engineering data, specs.
242A Clark Bros. Co.

Pump.....ideally suited for handling corrosive materials. Complete information on this high-quality pump—performance curves & specifications—is offered in Bulletin 624A4.
120 *Goulds Pumps, Inc.

Pump.....chemical proportioning pump in both fixed & variable stroke models, piston & cylinder assembly interchangeable in housing. Handles pressures to 60,000 psi, & capacities to 31 gal/hr. Bul. 4065.
93 *American Instrument Co.

Pumps.....full ball bearing single suction pumps feature high efficiency bronze impellers, easily-renewable bronze wearing rings, sturdy cast iron bearing stand & casing mounting ring. Bul. 976-E.
106 *Buffalo Pumps.

Pumps.....Three ways to keep organic contaminants out of a vacuum with mercury, electronic, & heraeus roots pumps. For information on these new developments in vacuum pumping, request. Bulletin 6-1.
244* Consolidated Electrodynamics.

Pumps, Turbine.....features water lubrication, two piece head shaft, stilling tube to keep suspended matter out of packing box, & special bearings, bearing retainers & pump bowls. Bulletin 6957-1.
137 *Fairbanks, Morse & Co.

Pumps, Vertical.....Vertical pumps handle hydrocarbons, hot and cold water, mild acids, basic and salt solutions. Outstanding net positive suction head characteristics. Bul. B-505.
126 *Peerless Pump Div.

Valves & Pumps, Diaphragm.....Request Valve booklet #104 & diaphragm pump booklet #301 for the inside story on a new concept in precision metering & proportioning of fluids.
216 *Hills-McCanna Co.

Valves, diaphragm.....horizontal & vertical types, provide positive check against reverse flow of gas or air. Prevents flow of air into gas lines when air & gas are used together. Bulletin 2000.
242B Norwalk Valve Co.

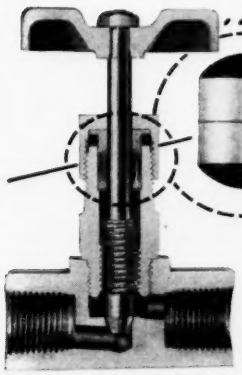
Valves, Drain.....the only valves that cannot clog up, designed so that in the closed position the piston or ram extends up into the tank. In the open position, full flow is assured. Request complete catalog.
201 *Strahman Valves, Inc.

Valves, Safety-Release.....new Farris reference Catalog simplifies selection & sizing. Contents include complete data on valves for process piping, dimension & weight tables & sizing factor curves.
205 *Farris Engineering Corp.

* From advertisement, this issue

"...yet we have IMPROVED it"

The Marsh Stainless Steel Needle Valve could have gone right on being the finest in its field...yet we have improved it



...with fabulous "TEFLON" packing

Note the "close-up." The Marsh Marpak packing system, originated in the Marsh Needle Valve, was one of the factors that has enabled it to stand up and work right under pressures up to 10,000 psi.

Now "Teflon" is used in this packing system—the miracle material of almost incredible *toughness, resilience* and *non-adhesive* properties...properties that are not impaired by the most powerful of solvents, acids, or alkalies even at temperatures *up to 500° F.*

Net result: The guaranteed application-range (up to 10,000 psi) is now effective at any temperature up to 500° F. (In other makes, permissible temperature decreases as pressure increases.)

Marsh Marpak Teflon Packing System is standard in Marsh 416 Stainless Steel Needle Throttling Valves. Ask for facts.

MARSH

Needle Valve in 416

stainless steel throughout

Now with "Teflon" Packing

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.*, **Dept. 24, Skokie, Ill.**

Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta

Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

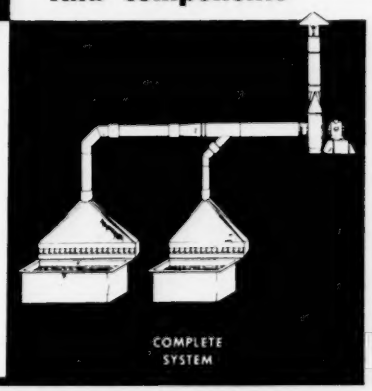
---

Leakproof

Corrosion-Resistant Polyethylene Fume Exhaust And Ventilating Systems And Components

... Cost Less ... are Easier To Install and Last Longer than Metal Installations.

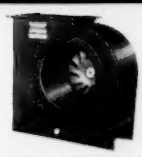
Prevent hazardous fumes from impairing health and production ... reduce excessive downtime and replacement cost with American Agile corrosion-resistant fabrication and components. They are light in weight, possess a high impact strength and provide exceptionally long service life. Send blueprints for quotation.



COMPLETE SYSTEM

VENTILATING DUCTS

HOODS



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AMERICAN AGILE Corp.

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TAPE BINDING ATTACHMENT

- Perfect tape-bound closures
- Complete portability maintained
- Quickly removed when tape binding is not required
- Simple! Versatile! Economical!

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Minneapolis 6, Minn.

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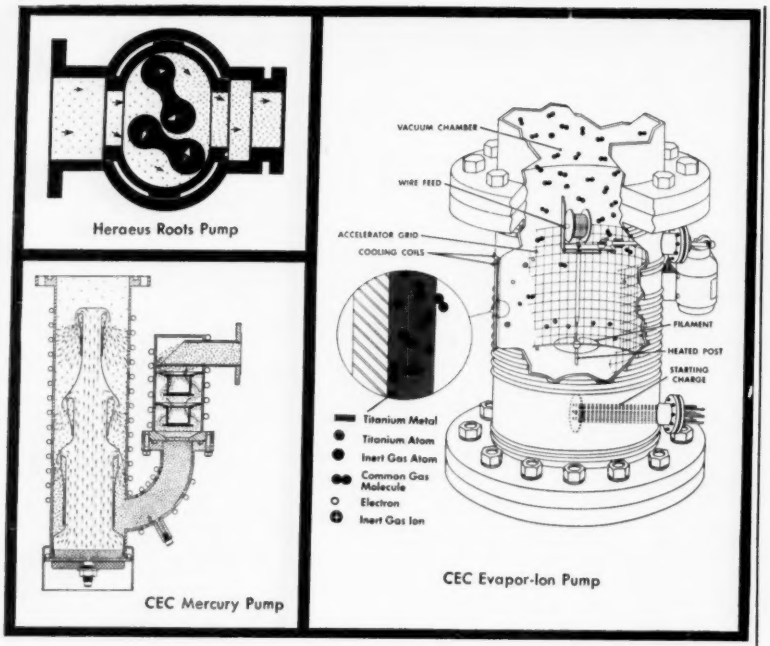
Firm Name_____

Address_____



NOW...three ways to keep organic contaminants out of a vacuum

CEC MERCURY PUMPS. Both metal and glass CEC mercury pumps eliminate the presence of organic vapors in a vacuum system.

The mercury itself does not decompose, is nonreactive with most process gases, and has known physical properties.

CEC Mercury Pumps

Pump Type No.	METAL					GLASS	
	MHG-50	MHG-180	MHG-300	MHG-900	*MHGS-20	*GHG-15	GHG-10
Operating Range (mmHg) 1×10^{-6} to	1×10^{-2}	3×10^{-3}	2×10^{-3}	2×10^{-2}	2×10^{-2}	1×10^{-4}	5×10^{-2}
Max. Speed (lit/sec)	120	205	500	1600	9.5	19	4.6

*MHGS-20 and GHG-15 are diffusion-ejector pumps. All the others are diffusion pumps.

CEC ELECTRONIC PUMP. The Evapor-Ion high vacuum pump uses no fluids. It uses the gettering action of evaporated titanium to rid systems of the active gases. It ionizes and entraps all the inert gases. The result is a completely dry vacuum in the 10^{-4} to 10^{-8}mm Hg range. Pumping speeds run as high as 1900 lit/sec. No mechanical pump is required for continuous operation.

HERAEUS ROOTS PUMPS. These positive displacement oilless mechanical pumps offer high pumping speed and operating economy in the 10^{-3}mm to 10mm Hg range, as well as a vacuum not contaminated by backstreaming oil vapors. Six models with speeds from 35 to 1600 lit/sec.

For information on all these pumps as well as the rest of the CEC pump line, write for Bulletin 6-1.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N. Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

LITERATURE . . .

Valves, Throttling.....Outside screw type for corrosion resistance, stainless steel stems with bronze mountings. Automatic or remote control with air, or hydraulic motor or cylinder. Free brochure.
202 .. .. .. *Shaffer Tool Works

Ventilating Systems.....corrosion-resistant polyethylene fume exhaust and ventilating components. Light weight, high impact strength, long service life. Hoods, ventilating ducts and fans. Free booklet.
BL243 *American Agile Corp.

Services, Processes, Misc.

Air polution.....is the subject of a free, 20-page booklet just issued to help develop fair & controlled air pollution laws. Principles essential to such legislation are defined. #1363.
113-14j *U.S.I. Chem. Co.

Encyclopedia of Chemical Technology.....has just been brought up-to-date through issuance of the first supplement volume to this series. It contains 51 articles covering adhesives, nuclear reactives. #1367.
113-14n *U. S. I. Chem. Co.

Film.....Super Hypan, finer grain, super-speed black and white film, is now available in 120, 620 and 20 exposure 35 mm. sizes. Speed flexibility makes film ideal for all types of picture taking.
244A Ansco.

Inhibitor, Corrosion.....Calgon composition TG, a sodium-zinc hexametaphosphate corrosion inhibitor is claimed superior in controlling corrosion in water mains and cooling equipment. Bulletin 420-12-9.
244B Calgon Co.

Laboratory Service.....Customer Service laboratory has an extensive line of small scale and pilot-size equipment for drying, evaporating, extractive, impregnation and crystallization. Cat. 381.
83 *Blaw-Knox Co.

Odor Control Systems.....Counteractant injects into airstream of odorous exhausts via atomizing nozzle. Once odor is identified, a specific counteractant is formulated for application. Info. avail.
244C Airkem, Inc.

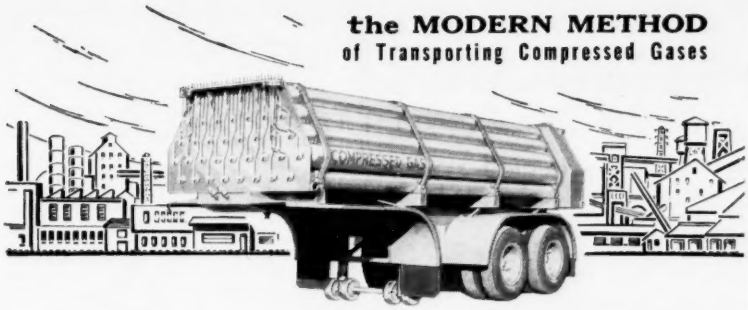
Preforms.....Bulletin 114 describes Epoxweld 100 preforms, single component epoxy preforms used in automatic or production joining, sealing or encapsulating metals, ceramics, glasses, quartz.
244D Duramic Products.

Rectification Plants, O_2 and N_2.....Rectification plants for the production of oxygen and/or nitrogen in liquid or gaseous form are described in new catalog. Technical data included.
244E Superior Air Products Co.

Water Conditioning.....Zero hardness water guaranteed with automatic Zeolite softening. For complete information on full line of Cochrane water conditioning equipment send for Publication 452-A.
117 Cochrane Corp.

* From advertisement, this issue

the MODERN METHOD
of Transporting Compressed Gases



IECO gas supply TRAILERS
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- CAPACITY — to meet YOUR Requirements
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RECTIFICATION

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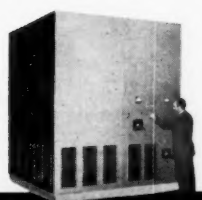

Of the thousands of Sel-Rex Rectifiers in use, a large percentage are "repeat orders"—units purchased only after an original installation had thoroughly proven itself.

Our users include the country's foremost electrical and electronic concerns* — companies best qualified to evaluate rectifier equipment.

**names on request*

Send for FREE "GUIDE" to Industrial Rectifier Equipment.

Rectifier Division
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NUTLEY 10, NEW JERSEY
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"Complete Semiconductor Power Conversion Systems for any AC to DC application"

Highly Intimate Blends in 1 to 2 Minutes

Blends while discharging; No segregation or flotation

Sturtevant Rotary Blenders start 4-way blending while charging, continue it during discharge, thus producing highly intimate, even blends of dry and semi-dry materials – within 3 to 5 minutes of start of charging.

Six *complete* blending cycles per hour are common. And Sturtevant's special action produces no particle reduction, cleavage or attritional heat – is highly effective yet gentle and safe even with explosives.

Receiving

Scoops cascade material as drum rotates. Movement forces material from both ends to middle. Thus blending is 4-way right from start of charging.

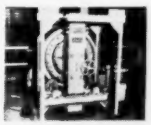
Discharging

Single gate controls charge, discharge. Blending continues throughout discharge phase. Result is no segregation or flotation — highly intimate, even blends.

Self-cleaning, dust-sealed drum; one-man accessibility

Operation of Sturtevant Blenders is self-cleaning – drum interiors are completely dust-sealed. For inspection of all models, one man simply loosens a few lugs to remove manhole cover – quickly and easily.

Nine standard models with capacities to 900 cu. ft.



10 cu. ft. Sturtevant Blender at U.S. Steel Corp.'s new Applied Research Laboratory (Raw Materials Division) in Monroeville, Pa. This unit handles batches up to 500 lbs. — is ideal for pilot work and small runs.

One of four 450 cu. ft. Sturtevant Blenders at Celriver Plant of Celanese Corp. (Rock Hill, N. C.). These large units handle up to 20,000 lbs. batches — have a 9-year record of meeting the most exacting blending requirements.

Fully or semi-automatic, or manually controlled operation

Constructed of carbon steel, stainless steel or Monel metal, Sturtevant Rotary Blenders are engineered to fit each customer's needs – can be supplied with injector sprays and any desired control system.

For more on Sturtevant Blenders, request Bulletin No. 080B. (Bulletins also available on Mixers, Air Separators, Micronizers, Crushers and Grinders.) Write today. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now.

▶**Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶**Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶**Closing date**—July 14th issue closes June 20th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

MORE CHEMICAL PLANTS ARE RENTING EQUIPMENT

Discover the Many Advantages

Baker Perkins Lab. Size S/S Shredder Mixer, 4.5 Cap. with cover.
Baker Perkins 100 gal. S/S Vac. Dbl. Arm Heavy Duty Mixer; Size 15; 75 HP motor.
15 Baker Perkins Heavy Duty Dbl. Arm Mixers; Capacity 100, 200 and 300 gal. each.
Lancaster Muller Type Mixer EAG 3; 5½ cu. ft.
J. H. Day S/S Dbl. Ribbon Jacketed Mixer; 81" x 30" x 33"; 280 gal., 10 HP motor.
Stainless Tumbling Batch Mixer; 17 cu. ft.
Sturtevant No. 10; 300 cu. ft. Tumbling Batch Blender.

Bagley & Sewell Double Drum Dryer; 28" x 60".
Gen. American Twin Drum Dryer 42" x 120".
Stokes Rotary Jktd. Dryer 18" x 8' with Agitator, Dust Collector.
Hersey Rotary Gas Fired Counter Current Dryer; 5' x 26".
Carrier Silica Gel Dehumidifier; Model RG.
Raymond 2 Stage Flash Drying System; complete.

6 A. T. & M. CENTRIFUGAL EXTRACTORS 60" x 20'
LINK SUSP. — TYPE 316 STAINLESS; VAPOR TIGHT

Patterson Steel Jacketed Dissolver, 84" x 48" with 20 HP explosion Proof Unipower Agitator.
Blaw Knox Stainless Resin Kettle or Reactor; 7'6" x 7'6".
Mojonnier Stainless Vac. Pans; 3' x 10' and 5' x 12'.
Pfaudler Glass Lined Jktd. Reactors; 500 & 1000 gal.
Lancaster S/S Lined Rotary Jktd. Reactor; 50" x 17'4".
Two 5,000 gal. Stainless Pressure Mixing Tanks; 10' x 9'6"; dished heads; slow speed agitators.
A. O. Smith Stainless Lined Pressure Tanks; 11,000 gal. 10' x 18'7"; 135 PSI.

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3' x 6' S.S. Oliver cont. vac. filter.
4' diameter S.S. 4 disc. vac. filter.
Sweetland #10 Filter 27 Steel Leaves.
24" Filter Press 36 NEW Wood P. & F.
30" Fletcher Stainless Susp. Cent. m.d.
40" Fletcher Steel Susp. Cent. m.d.

COLUMNS

6' x 29" Bubble Cap Column S.S. 347.
9' x 42'6" Column 410 S.S. Lined 150 PSI.
30" Copper Column with 24" Rectifier.

MIXERS—MILLS

2 000# Ribbon Blender m.d.
14" x 30" Day 3-Roll High Speed.
Raymond #40 Imp. Mill.
3'6" x 6' Pebble Mill.
Raymond 6 Roll High Side Roller Mill.
Jeffrey 20" x 12" type "A" Hammer Mills.

VESSELS

750 gal. jktd. Steel Reactor 300 PSI.
50 gal. jktd. Stainless Reactor 50 PSI.
12 000 gallon Aluminum Tank 75 PSI.
6 000 gal. S.S. hor. tank.
2,450 gal. S.S. hor. tank.

KILNS—DRYERS

705-24 Roto-Louvre Dryer, Complete.
502-16 Roto-Louvre Dryer, Complete.
8'6" x 50' Allis Chalmers Kiln.
6' x 50', 6' x 30' Louisville Rotary Steam Tube Dryers.
5' x 40' Rotary Kiln 3/8" Shell.
4' x 20' Ruggles Cole Model XH2.
6' x 10' Rotary Vacuum Drum Dryer.
32" x 100" double drum dryer.

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HEAT & POWER Co., Inc.
PROCESS EQUIPMENT DIVISION
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310 THOMPSON BLDG. TULSA 3, OKLAHOMA Diamond 3-4890

MACHINECRAFT

Stokes 3-DD52, 1-T, 1-RD3, 2-B.
Baker Perkins 100 gal. S.S. double arm 50 HP jacketed, vacuum, hyd tilt.
Blaw Knox 2 gal. S.S. Autoclave 5000 lb.
50 gal. S.S. Autoclave 2000 lb. press.
Vulcanizer 60 in. x 9 ft. 125 lbs.
Oliver S.S. Pressure Filter.
Sweetland #2 all Stainless.
Stainless Steel Ball Mill.
Aluminum Condenser 350 sq. ft.
4-24 in. Filter Press S.S. Fittings Wd. Fr.
1-24 in. Filter Press open delivery.
2-Colloid Mills.
2-Proctor & Schwartz finned drum driers.
Continuous stripping column 2 x 13 steel.

LOUIS SUSSMAN, INC.
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

ECH SPECIAL

Baker Perkins 150 cu. ft. SS Jktd. Ribbon Mixer for dry or wet materials. Price $3750.
You Can Bank on
Equipment Clearing House, Inc.
111 33rd Street Brooklyn, N. Y.
South 8-4451—4452—8782

ROTARY KILN

Size: 6 ft. Dia. x 124 ft. long
Thickness: 5/8" plate
Drive: 15 HP motor, 870 r.p.m., Westinghouse varied speed. Total reduction 378 to 1.
Speed: 1/2 r.p.m.
BONDED EQUIPMENT CO.
24155 Schoenherr Rd., Warren, Mich.
PRescott 8-6640

LIQUIDATION

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DONORA, PA.

(In Conjunction with Kaiser Nelson Co.)

CRUDE ORE PLANT: Steel Building, 73' x 310' x 50' high with Alliance 15 ton traveling Crane; 2—Ruggles Cole 90" x 55' Class A-14 Rotary Dryers; 1—Christie 80" x 65' Rotary Dryer; Apron and Belt Feeders; 4—54" x 24" Roll Crushers; 2—Kennedy No. 6 Gyratory Crushers; Belt Conveyors and Belt Feeders, 18" to 84" wide; Screw Conveyors and Bucket Elevators; Bins and Hoppers; Skip Hoists; Motors and Gear Reducers, etc.

ROASTING AND PRECIPITATOR PLANT: 2—Nichols Herreshoff Furnaces, 20' dia., 16 Hearth with Conveyors, Hoppers; 2—two section Cottrell, plate and wire type Precipitators; 24" Belt Conveyor 315' centers; 24" Belt Conveyor 175' centers; Bins, etc.

SINTERING AND PRECIPITATOR PLANT: Steel Building, 62' x 135' x 87'6" high with Alliance 15 ton traveling Crane; 2—Dwight Lloyd Sintering Machines with Apron Feeders (7 tons per hr. each); Belt Conveyors; Bins; Pug Mills; 1—five section Cottrell round tube and center wire type Precipitator 90,000 cfm at 195°F; Motors, etc.

SPELTER FURNACE PLANT: 10 Steel Buildings, 70' x 170' x 24' high with 20 Gas Producers; 10—Furnaces with Waste Heat Boilers and Conveyors; Jaw Crushers; Larry and Transfer Cars; Track; Motors; Drives; etc.

POTTERY PLANT: (Mfg. Crucibles and Condensers for Spelter Furnaces.) 2—9' Heavy Duty Dry Pans; 2—Condenser Machines; 2—Pug Mills, 13⅜" dia. opening; 2—Retort Presses; Bins; Screw Conveyors; Bucket Elevators; Motors, etc.

MIXER PLANT: Steel Building, 145' x 100' x 60' high with Alliance 20 ton Crane; Hardinge 5' x 10' Rod Mill; Bins; Hoppers; Larry Cars, etc.

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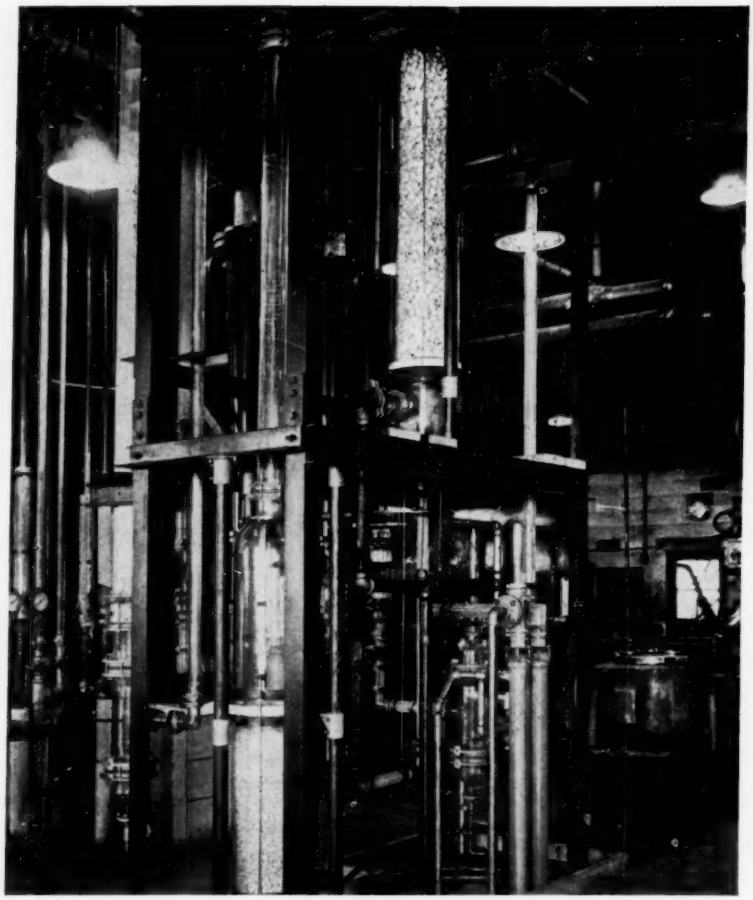

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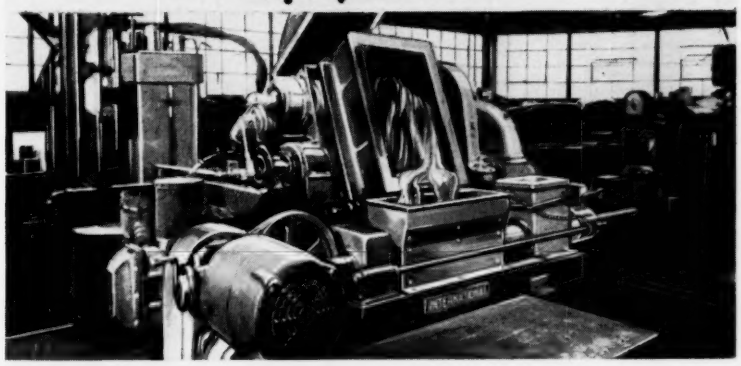

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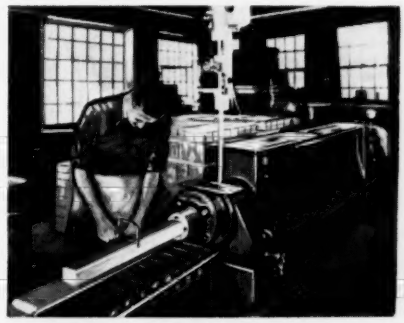

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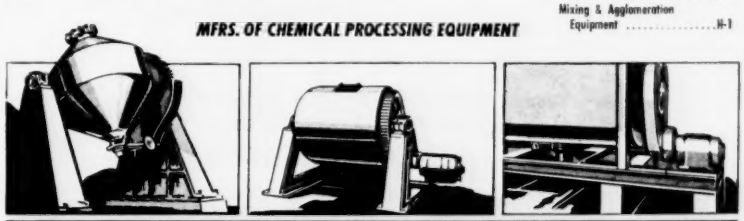

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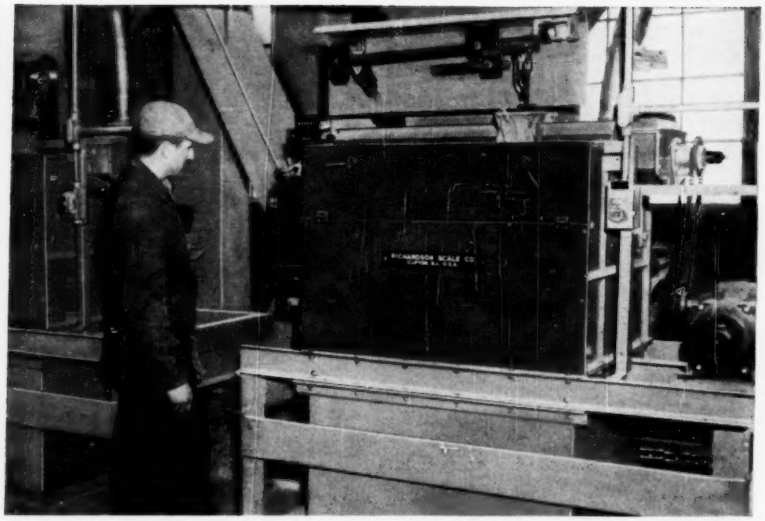

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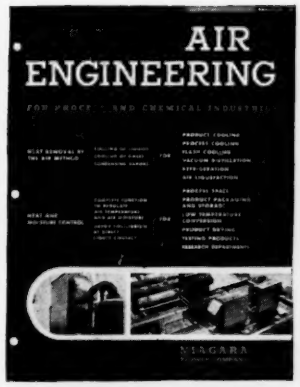

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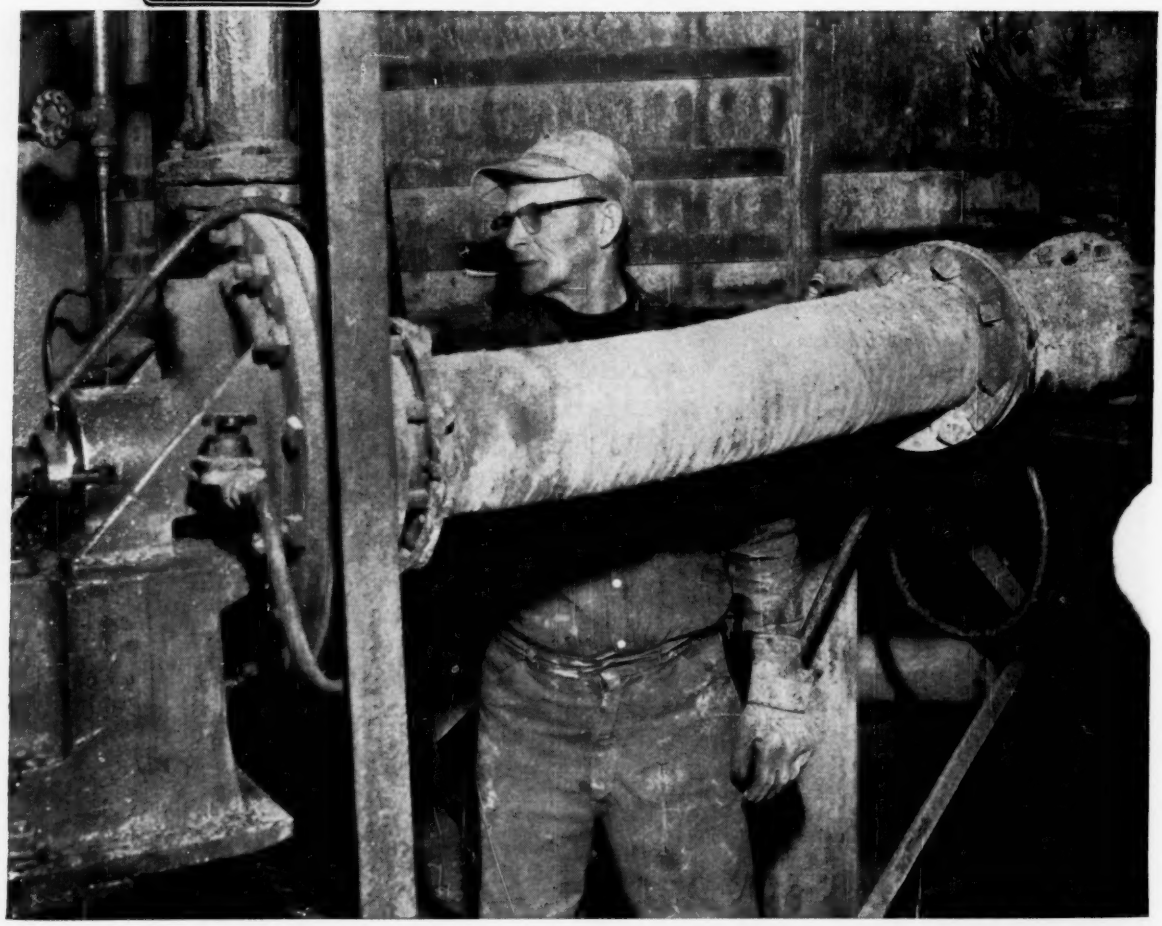

Bang, rattle, shake– pipes were cracking up

B. F. Goodrich improvements in rubber brought extra savings

Problem: That powerful pump at left draws hot acid at 400 gallons a minute from tanks, then shoots it through big pipes. The pump vibration shook the pipes until they clanged, rattled and shivered, gradually cracked, leaked, lost corrosive acid that damaged equipment. Pipes had to be replaced two or three times a year.

What was done: The plant superintendent, working with a B.F.Goodrich distributor, decided to replace a short length of lead pipe between the tank and pump with a B.F.Goodrich Flexseal Connector. This is a special kind of hose, made of thick, resilient rubber, which is designed to absorb the pump vibrations traveling along pipelines.

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Where to buy: Your B.F.Goodrich distributor has exact specifications for the B.F.Goodrich hose described here. And, as a factory-trained specialist in rubber products, he *can* answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Company, Dept. M-371, Akron 18, Ohio.*

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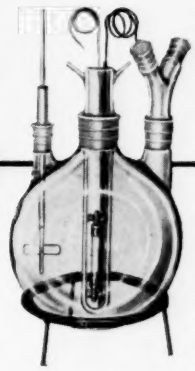

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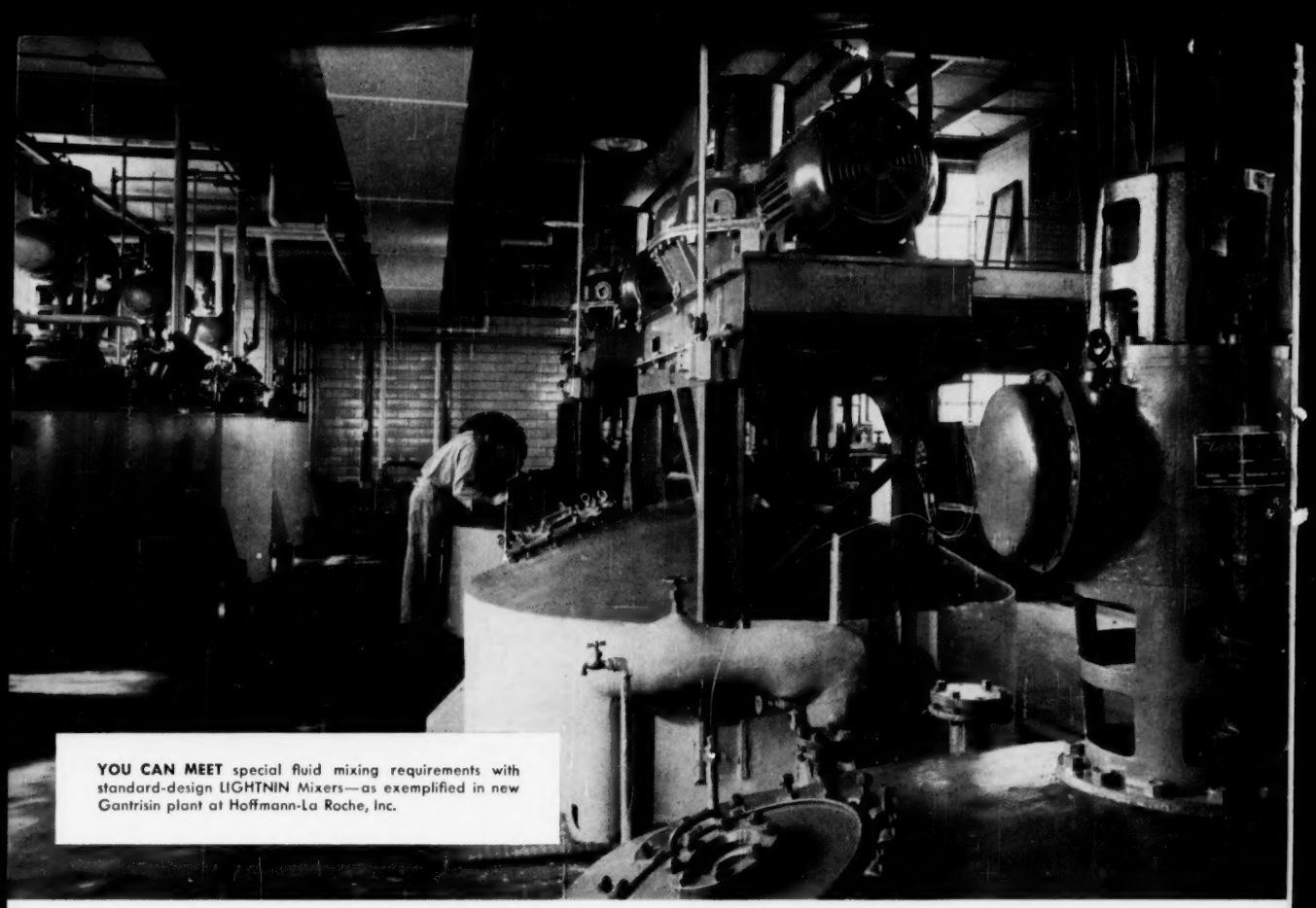

YOU CAN MEET special fluid mixing requirements with standard-design LIGHTNIN Mixers—as exemplified in new Gantrisin plant at Hoffmann-La Roche, Inc.

Good mixing helps clear up tough crystallization problem

Does formation of uniform crystals pose a tricky processing problem for you? Maybe the answer lies in good mechanical mixing.

This is true at Hoffmann-La Roche, Inc., Nutley, N. J., where a highly automated new plant has started turning out Gantrisin, a broad-spectrum sulfa drug, at double the previous rate and with 40% less manpower.

Mixer prevents clogging

Crystal formation takes place in brine-cooled kettles, which are constantly mixed from 10 to 12 hours while batch temperature drops from 200° F to 30° F.

Thorough mixing is essential, since an unevenly cooled batch can cause clogging of the bottom outlet, and expensive time loss.

As viscosity increases in the cooling batch, load on the mixer builds up sharply. In addition, extremely small clearance is required between the mixer impellers and vessel wall.

Could Hoffmann-La Roche satisfy all these conditions without going to special mixer design?

Could—and did

Not only in the crystallizers, but in every fluid mixing operation in the new process, Hoffmann-La Roche meets the requirements with *standard-design* LIGHTNIN Mixers.

Nine LIGHTNINS, ranging in size from 3 to 40 HP, perform a variety of mixing jobs—and enable Hoffmann-La Roche to standardize on spare parts, simplify maintenance routine and operator training.

The company has used LIGHTNINS for more than 20 years; currently has more than 200 in operation.

Reduce long-term cost

No matter how specialized your processing needs may be, it costs you nothing to determine whether LIGHTNIN Mixers can meet them. And when you specify LIGHTNINS, you get *guaranteed* mixing results, based on unique scale-up data from many thousands of pilot runs.

You enjoy the long-term cost advantage of *standard* mixer construction, with interchangeable parts and components always available.

And you save further with "flex-protected" design and many other refinements that keep your maintenance costs low.

For quick, competent help on fluid mixing, see your LIGHTNIN Mixer representative now. He's listed in Chemical Engineering Catalog. Or write us direct.

What Mixing Operations are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

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- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ LIGHTNIN CM Contactor for processing fluids continuously (B-515)

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